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THE NATURAL HISTORY OF A POLYMORPHIC BUTTERFLY.*

BY SAMUEL H. SCUDDER.

This butterfly (*Iphiclides Ajax*) occurs east of the great plains, in the Carolinian and the southern half of the Alleghanian fauna; it extends north almost to the annual isotherm of 50°, even passing that line in the region of the great lakes, so as to include southern Michigan and the whole of Ohio, but, apparently, not following the upward curve of the isotherm beyond the Mississippi. In the south it reaches the gulf coast, but how far it extends down the Florida peninsula is undetermined; its western extension is unknown; it has been reported neither from Texas nor Arkansas, although it is common in Missouri (Riley). Prof. Parker states that it occurs on the Mississippi at least as far north as Rock Island, Ill., and that he has taken a few specimens at Keokuk and Davenport, Iowa, although none at Grinnell. It occurs in southern Michigan (Mus. Mich. Univ., Andrews) and in many localities in Ohio, such as Cleveland—"not uncommon" (Kirtland); "common where papaw bushes are" (Kirkpatrick); Columbus, "still more abundant" than at Cleveland (Kirtland); Rockport, Poland and Hudson (Kirtland) and Eastern Ohio (Foster); a single specimen has been reported from Komoka, Ontario, Canada (Saunders). In

* This article is an extract from the chapter upon *Papilio Ajax* in Mr. Scudder's forthcoming work upon the Butterflies of New England and the adjoining regions; this will account for the form in which it is here presented.—Eds. Nat.

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Maryland (Uhler) it is "rare" and about Philadelphia (Blake) it is not common. Finally, one specimen has been taken near Brooklyn, N. Y. (Graef *fide* Akhurst).

As in some other dimorphic species, however, the distribution of the several varieties does not seem to be coextensive with that of the species. Unfortunately, our information here is very meagre, since the polymorphism of the insect has only recently been proved. It is, however, certain that the numerical superiority of the variety Marcellus over Walshii and Telamonides is far greater in the north than in the south; indeed, near the northern limit of the insect's range, Walshii and Telamonides are hardly known, and in extreme northern localities where only a few specimens have been recorded, these have always been Marcellus.

The caterpillar, according to numerous authorities, feeds upon the papaw (*Asimina triloba* Dunal) and, according to Dr. Chapman, upon other species of the same genus such as *A. parviflora* Dunal, *A. grandiflora* Dunal, and *A. pygmæa* Dunal. Boisduval and Le Conte also state that it feeds upon the latter and upon *A. palustris*,—plants belonging to the Anonaceæ or custard-apple family.

Some of the caterpillars, as shown by Mr. Edwards' observations, attain their full growth in twelve days, although others, especially the produce of the form Walshii, require nearly a month. They do not draw the leaves of the plant together like the larvæ of the genera represented by Troilus and Glaucus. They are to be found in every stage "resting on the surfaces of the leaves, and one would suppose they must be nearly exterminated by birds. But like all Papilio larvæ they emit from the head [first thoracic segment], at the same time that they project a Y-shaped tentacle, a peculiarly acrid and sickening odor, which must effectually protect them."* In a letter, Mr. Edwards adds that he does "not believe a starving bird would touch one, the stench being so strong as nearly to turn one's stomach."

Science is deeply indebted to Mr. Edwards, for the thorough manner in which he has worked out the history of this butterfly by careful studies in the field and innumerable experiments. This author has not only indisputably established the identity of two forms previously described as distinct species (though often presumed to be identical), but has proved the existence of a third per-

* Edwards, Butterflies N. America, part ix.

manent form and has admirably traced the relations of each form to the others. The account given below is almost entirely based on his observations.

No histories of butterflies are of deeper interest than those of polymorphic species, whether considered in themselves alone or in the light they are destined to throw upon the origin of species and races, problems which demand the profoundest thought and most conscientious investigation; and since this species is polymorphic in a larger sense than any other American butterfly is known to be, our interest is greatly enhanced.

As hinted above, Ajax appears under three different forms — Walshii, Telamonides and Marcellus, the polymorphism affecting both sexes equally. These forms are shown by Mr. Edwards to produce one another in a complicated manner, but in general the imago exhibits what has been termed seasonal polymorphism; that is, a series of individuals adhering, in all their variations, to several distinct types, each type appearing at a different season of the year from the others; thus Walshii is the early spring type, Telamonides the late spring, and Marcellus the summer and autumn type. Nearly all the butterflies which, in West Virginia, emerge from the chrysalis before the middle of April are Walshii; between that and the end of May, Telamonides; after this, Marcellus. The first two, however, do not appear properly to represent distinct *broods;* and this point (to which Mr. Edwards has failed to draw special attention) is one of the most extraordinary features in the history of the insect; for Telamonides, judging from his recorded observations, is not the direct conseasonal produce of Walshii, but both are solely made up of butterflies which have wintered as chrysalides, those which disclose their inmates earliest producing Walshii, the others, Telamonides; while all butterflies produced from eggs of the same season — and there are several successive broods — belong to Marcellus. Thus, besides the true seasonal dimorphism which distinguishes the butterflies produced from eggs of the same season from those derived from eggs of the previous season, we have a secondary seasonal dimorphism, as it may well be called, separating the earlier from the later produce of wintering chrysalides.

Mr. Edwards has also proved by his experiments that a portion of every brood of chrysalides, instead of disclosing the imago at the end of the ordinary time, retain it, occasionally until the ap-

pearance of a subsequent brood, but usually until the next spring. The spring brood (Walshii-Telamonides) is therefore by no means wholly produced from chrysalides of the final brood of Marcellus, but in large measure from those of all the earlier broods, even including the earliest Walshii; the proportion of chrysalides which continue until spring increases as the season advances, Mr. Edwards' statements showing that of those produced from eggs laid in April, more than ten per cent. pass over, those from eggs laid May 1-25 about thirty-five per cent., from that time until the end of June from fifty to sixty per cent. and from those laid in July about seventy per cent. Walshii and Telamonides, then, produce Marcellus the same season, or either Walshii or Telamonides in the spring; Marcellus produces itself the same season, or one of the others in the spring; but neither Walshii nor Telamonides is produced the same season by any of the varieties.*

We will now consider the life-history of Ajax. The insect is multibrooded and winters as a chrysalis. The earliest variety, Walshii, "appears in the Kanawha valley (W. Va.), from the 15th to 20th of March, by which time the peach trees are usually in blossom. On these the females may certainly be found, and a little later, on the apple and in great numbers on the wild plum. The males appear a few days earlier [than the females] and are to be seen by the water-side or upon the road, but rarely upon flowers. The larvæ feed on the papaw, and as this is one of the latest of our trees to put forth its leaves, the butterflies are out at least from two to three weeks, before the young shoots of the food plant are visible. But no sooner do these appear than the females hasten to deposit their eggs."† This is early in April and they

* The recorded exceptions to this rule (which serve only to strengthen it) are the following: a Telamonides was captured September 12th, and a Marcellus April 11th; the other exceptions occurred in the course of Mr. Edwards' experiments. This indefatigable worker has traced the history of more than two hundred individuals from egg to butterfly, and of these only two did not follow the usual course; these two belonged to a brood produced from eggs laid by Walshii before the middle of April; sixty individuals completed their transformations the same year; all (excepting a pair of belated Marcellus) hatched between June 1st and 6th; fifty-eight chrysalides produced Marcellus, one Walshii and one Telamonides; so that the solitary specimen of Walshii was far out of season, for Mr. Edwards expressly says: "about the first of June Walshii *disappears*" while the one specimen of Telamonides was certainly much later tha usual; and in any case, Walshii should produce neither Walshii nor Telamonides the same season. It must be remembered that similar instances of untimely eclosion are by no means very uncommon among butterflies.

† Edwards, Butterflies of N. America. Unless otherwise stated, all these remarks are based upon Mr. Edwards' observations in W. Virginia.

continue to lay them until as late as May 23d; the eggs hatch in from seven to eight days and the caterpillars are from twenty-two to twenty-nine days in attaining their growth.

Telamonides, which, as stated above, is only a later variety of the same brood, "begins to fly some weeks after Walshii, and both forms . . . . are for a time common." Telamonides evidently lays its eggs very soon, for "on dissecting the abdomen of a newly emerged female, the eggs are found to be fully formed though not full-sized. I conclude that they mature with great rapidity because fertile eggs are laid by apparently fresh and uninjured females." Mr. Edwards records eggs laid from May 11th to June 2d; these are hatched much more rapidly than those of Walshii (although they are not always laid later in the season), namely, in from four to five days; the caterpillars, too, mature more quickly, attaining their growth in from fifteen to eighteen days, thus often overtaking their tardier predecessors. "About the first of June Walshii [imago] disappears, and before the end of the month Telamonides also."

Still farther south, it is evident that the apparition of the butterflies is advanced; for in Georgia, Abbot records Walshii as emerging from the chrysalis March 2d, and Dr. Chapman took it in northern Florida, in the latter half of February, 1868 and 1869; late in March he also records the species as "numerous," so we may perhaps fairly surmise that Telamonides appears at this time.

"About the first of June, Marcellus begins to appear and shortly is out in great numbers, continuing to be abundant till last of October." The broods overlap each other so as to be distinguished with difficulty, but it appears that, besides the brood of Walshii-Telamonides already mentioned, there are at least three successive broods of Marcellus.* The larvæ of Telamonides, as we have seen, often overtake the later larvæ of Walshii—the earlier larvæ are by this time (the middle of May) in chrysalis and continue fourteen days; the first brood of Marcellus from these chrysalides, and from those of Telamonides, continues to emerge until at least the ninth of July, or for more than five weeks.† The chrysalides

* Mr. Edwards' language on this point seems a little vague; he says: "Besides the first brood from Walshii, or Telamonides, there are three successive broods of Marcellus, and the larvæ of the fourth give chrysalides that go over the winter, thus making five broods per year."

† Speaking of a brood of larvæ from eggs of Walshii, reared in 1871, Mr. Edwards says that while the mass of the chrysalides (all of which suspended within a week of

from larvæ of Telamonides hang from eleven to fourteen days, and the time for the completion of their entire cycle is only from thirty to thirty-seven days, which is seldom exceeded by Marcellus (twenty-seven to thirty-eight days), although much quicker than the period of Walshii (forty-three to fifty-one days).

The female of the first brood of Marcellus commences to lay eggs — which, like those of Telamonides, hatch in four or five days — at the very beginning of June, and butterflies produced from them, *i. e.* the second brood of Marcellus, are upon the wing early in July — not only before the butterflies of the previous brood have disappeared, but even before all the chrysalides from eggs of Telamonides have eclosed their butterflies; the attempt to trace the sequence of the broods is, therefore, almost hopelessly bewildering; but it seems probable that the second brood of Marcellus (the third of Ajax) appears in abundance early in July; it is, perhaps, in speaking of the first brood of Marcellus in Alabama, that Gosse says they are "nearly all gone July 1st." These larvæ attain their growth in from twelve to nineteen days, and hang as chrysalides from eleven to fourteen, and it is therefore impossible that there should not be a third brood of Marcellus; that a fourth brood is even at times possible would appear from the fact that the insects continue to change from one stage to another without any apparent regard to the approach of winter, which overtakes many in conditions under which they are obliged to succumb; thus Mr. Riley writes from Missouri: "I have found eggs and larvæ two-thirds grown, as late as the middle of October, when the leaves were almost all fallen; the parent ought to know better if instinct is so infallible." Doubleday remarks that on the Ohio the species was very numerous after the tenth of September; if this is an indication of a new brood in September, and if the second brood of Marcellus appear early in July in this locality also, then the butterflies seen by Doubleday must have been a fourth brood of Marcellus, or the fifth of Ajax. I do not think there is another instance on record of a five-brooded butterfly.

The results reached by Mr. Edwards in his study of this butterfly have recently been the subject of some curious comments by

each other) eclosed the butterflies between June 1st and 6th, yet "on 23d June, full three weeks after its period, came another ♀ Marcellus and a second followed on the 12th of July;" but even the latter date is only three days after that of others of this brood (from eggs of Telamonides however), which were but thirty-seven days from egg to butterfly.

Mr. Meldola of England, in a paper upon the "amount of substance waste undergone by insects in the pupal state."*

This writer thinks he has shown that the comparative size of the three forms of Ajax is exactly opposite to what we should expect. In his preliminary general remarks, it is presumed *a priori* that as there is in all insects gain of matter in the larval state, and loss during the pupal, the size of an individual of any given species "would be, *cæteris paribus*, inversely proportional to the ratio of the pupal to the larval period, or directly proportional to the ratio of the larval to the pupal period."

He attempts to test this theory by tabulating the statements of Mr. Edwards concerning the duration of the stages in the different forms of Ajax, and he finds that there is "a relationship but exactly the reverse of that which would be anticipated from the conclusions previously set forth."

Walshii, Telamonides and Marcellus, as we have seen, succeed each other in season; they also increase regularly in size in the same order. The following table represents the duration of the several stages and is taken by Mr. Meldola from Mr. Edwards' work.

NAME OF VARIETY.	EGG.	LARVA.	CHRYSALIS.	TOTAL.
Walshii . . .	7–8 days	22–29 days	14 days	43–51 days
Telamonides	4–5 "	15–18 "	11–14 "	30–37 "
Marcellus . .	4–5 "	12–19 "	11–14 "	27–38 "

The next table is Mr. Meldola's attempted tabulation of the facts, by which he comes to the above conclusion.

NAME OF VARIETY.	RATIO OF MEAN PUPAL TO MEAN LARVAL PERIOD.	RATIO OF MEAN LARVAL TO MEAN PUPAL PERIOD.	MEAN EXPANSE ♂.
Walshii	$\frac{14}{25 \cdot 5} = 0{\cdot}549$	$\frac{25 \cdot 5}{14} = 1{\cdot}821$	2·70
Telamonides .	$\frac{12 \cdot 5}{16 \cdot 5} = 0{\cdot}757$	$\frac{16 \cdot 5}{12 \cdot 5} = 1{\cdot}320$	3·00
Marcellus . . .	$\frac{12 \cdot 5}{15 \cdot 5} = 0{\cdot}806$	$\frac{15 \cdot 5}{12 \cdot 5} = 1{\cdot}240$	3·35

"It is here seen," says Mr. Meldola, "that the size of the variety is directly instead of inversely proportional to the ratio of the

* Ann. Mag. Nat. Hist., Oct., 1873, p. 301.

pupal to the larval period, and *vice versâ*." Unfortunately for this conclusion the figures given by Mr. Edwards, or their reduction by Mr. Meldola, refer in each case to the *progeny* of Walshii, Telamonides and Marcellus, and do not bear upon the question at all. In every instance given in the tables, the progeny or resultant is Marcellus. By Mr. Meldola's rule, Walshii and Telamonides, being the produce of wintering chrysalides, should be, as they are, smaller than Marcellus, since the latter is always the result of short-lived, summering chrysalides; unless, however, some unknown factor plays a part, Telamonides should be smaller than Walshii, because produced later in the season from wintering chrysalides; but here the opposite is the case.

The extreme abundance of Ajax is well attested by Edwards, when he says: "at certain seasons it is almost impossible to find a young plant [of papaw] that is free from . . . . eggs and it is easy to collect scores of them."

"The female of Ajax may frequently be seen coursing through the papaw trees which . . . . . cover the lower hillsides, or hovering about the young plants that spring up in the cultivated fields, searching for leaves on which to deposit her eggs. After touching or running over and rejecting several, she finds one suitable to her purpose. Thereupon balancing by the rapid fluttering of her wings, she stands for an instant with legs stretched at full length, perpendicular to the body, and curving down the abdomen until it touches the surface, deposits a single egg; then flies away, presently to alight on a second leaf with like intent. Sometimes the egg is upon the stem, and occasionally on the under side of the leaf, but almost always it is upon the upper side, and but one egg will usually be found on the same leaf. The process of laying continues for several successive days." (Edwards).

Doubleday, speaking in particular of the spring-brood writes:* "I rarely saw it alight on flowers. Now and then it would alight on flowers of *Anona grandiflora* . . . . . its flight low, rapid (not sailing with its wings expanded as *P. Thoas* and others). It flies in and around the low scattered brush wood, by the sides of clearings, old deserted cotton fields, and similar situations, often returning to the same spots; in fact so regular did the round seem to be taken, that I have often waited behind a bush for a few minutes for the return of an individual I had seen pass, and rarely failed

* Arcana Entomologica, i, 61.

by this means to capture it. It is a shy insect and darts out of its course at the least motion." Speaking of the autumn brood, which he considers a distinct species, he adds (*loc. cit.*): "its flight is rather more graceful than that of *P. Ajax* [*i. e.* the spring brood]; it sometimes alights in the muddy places by the roadsides where little streamlets cross, especially during the heat of the day." Kirtland, too, remarks: "these two species are readily recognized by their peculiar mode of flight;"* but Edwards makes no comment upon this point.

"Many eggs," says Edwards, "are destroyed by insects and spiders. There is a minute scarlet spider scarcely larger than the egg itself, that mounts upon it and from a puncture extracts the contents. I frequently met the shells so despoiled before I discovered the cause, and have since observed the marauder in its operations. I have also lost in a single night, owing as I supposed to crickets, numbers of eggs laid in confinement." Speaking of the caterpillar he says: "I have . . . seen spiders feeding upon them, attacking even the head, and they have other enemies among the insects. They are very little troubled by ichneumon flies in this valley, and I have rarely lost a chrysalis from that cause. Consequently no Papilio is so abundant here throughout the season. I find on breeding them that a considerable percentage of the eggs do not hatch, and that more or less of the larvæ die at every moult, as well as in the effort to change to chrysalides. Multitudes of chrysalides must be destroyed in the winter by birds and mice as they are but imperfectly concealed under stones and roots, or even among the stems of the grasses, so that of the tens of thousands of eggs that are annually deposited, but a very small proportion produce butterflies." The caterpillar is, however, sometimes attacked by *Trogus exesorius* Brullé, the imago of which escapes from the chrysalis by cutting a circular opening, usually through one of the wings.

Desiderata. Although so carefully studied by Mr. Edwards, there are still some points in the history of Ajax which require investigation. The distribution of the insect in the west and of each form throughout its natural range should be more definitely determined. The season of the apparition of the different varieties in the extreme southern states, and of the different broods of Marcellus everywhere, is still unknown and will require careful study;

* Trans. Entom. Soc. Lond., n. s. i, 1851, Proc. ci.

but perhaps the most interesting and fruitful investigation will be to follow still further the line of Mr. Edwards' experiments, and study the proportion of chrysalides of each brood which retain their inmates until spring; noting every instance of the partial retention of the chrysalis, to discover to what extent pupæ, apparently destined to hibernate, disclose the butterfly the same season; and, further, to determine whether both Walshii and Telamonides are indifferently produced from any of the broods of the previous year. Mr. Meldola's studies would lead us to conjecture that Walshii is generally produced from the later broods of Marcellus, and Telamonides from the earlier broods of the same, and from Telamonides and Walshii; but Mr. Edwards' experiments show that this is not invariably the case. The postures of the butterfly have not been described.

THE GAME FALCONS OF NEW ENGLAND.
THE SPARROW HAWK.

BY DR. WILLIAM WOOD.

This beautiful little hawk has the peculiar markings of the true falcon, and is the smallest and handsomest of the family Falconidæ. It is found all over the continent, and is said to be the most numerous of the hawk family. While this no doubt is the fact, yet in New England it is not common. It is about as rare as the pigeon hawk, but not so irregular in its visitations. I have received only ten specimens in twenty years. Allen in his ornithological notes on the birds of the Great Salt Lake Valley says, "The sparrow hawk was by far the most numerous of the Falconidæ. Thirty were seen in the air at one time near the mouth of Weber Cañon engaged in the capture of the 'hateful' grasshopper, which everywhere filled the air and which seemed at this season to form the principal food of this and other birds." In the southern states where it is very numerous it may be seen about the old fields, orchards and gardens, sitting erect on a fence, stake, mullein stalk, or a dead limb of a tree, watching for small birds, mice, grasshoppers or beetles, upon which it chiefly subsists, seldom

committing depredations among the young poultry. When leaving its stand it usually flies low and swiftly, and just before reaching its intended perch rises up with a semicircular sweep, and alights with ease, instantly closing its wings and keeping its balance by the motion of its tail, not using its wings for that purpose, as do most hawks when alighting. They become very much attached to one particular spot and may be seen for weeks and months occupying the same stump or stake. Their flight is usually short and irregular; sometimes hovering for a short time with suspended wings, reconnoitring for prey, and then flying off to another place to renew the same manœuvre. They are easily domesticated. Audubon relates an instance of his taking a young bird and providing it with food until able to hunt for himself, when he let him go. "This proved," says Audubon, "a gratification to both of us. It soon hunted for grasshoppers and other insects, and returning from my walks, I now and then threw up a dead bird high in the air which it never failed to perceive from its stand, and towards which it launched with such quickness as sometimes to catch it before it fell to the ground. To the last he continued kind to me, and never failed to return at night to his favorite roost behind the window shutter. His courageous disposition often amused the family, as he would sail off from his perch and fall on the back of a tame duck which, setting up a loud quack, would waddle off in great alarm with the hawk sticking to her. In attempting to secure a chicken one day, the old hen attacked him with such violence as to cost him his life." When they first appear in the spring, their gyrations and cooings are very amusing. No falling in love at first sight can be more amorous. Audubon has described it so graphically that I venture to quote. "When spring returns, each male bird seeks for its mate, whose coyness is not less innocent than that of the gentle dove. Pursued from place to place, the female at length yields to the importunity of her dear tormentor, when side by side they sail screaming aloud their love notes. With tremulous wings they search for a place in which to deposit their eggs; the birds sit alternately, each feeding the other and watching with silent care. The family resort to the same field, and each chooses his stand, stake or mullein stalk, and together hunt." The sparrow hawk is somewhat dainty, refusing to eat woodpeckers or tainted food, and it is said if it catches a mouse which proves to be lousy and

poor, it will leave it and seek another. It nests in hollow trees, frequently occupying an old woodpecker's hole; sometimes, though rarely, it has occupied an old crow's nest, seldom constructing a nest for itself, laying usually four eggs, of very uniform size. By taking one egg of a set from four sets and three states, I find the measurements as follows:

From	Pennsylvania,	long	diam.	1·30.	Short	diam.	1·12.
"	Maine,	"	"	1·33.	"	"	1·13.
"	Connecticut,	"	"	1·30.	"	"	1·13.
"	"			1·38.	"	"	1·15.

The markings are somewhat variable, not any more so, however, than most of the eggs of our hawks. The ground color varies from a cream to a deep buff, blotched with small dark brown or chocolate spots, sometimes quite sparsely, then again almost confluently; occasionally the blotches are quite thick at the large or small end, more commonly the former, and in some instances at both ends with few in the middle. Nuttall claims that this bird "lays from four to five eggs." Dr. Brewer says "its eggs are usually as many as five in number." Audubon says "it lays from five to seven, never less than five." It may in some sections lay that number of eggs, but such has not been my experience in New England, having known of only one set of five taken in this vicinity. One of my collectors found a nest with four eggs in the top of a stump about ten feet from the ground, where it evidently had been broken off by the wind. This nest was composed of grass, and was discovered by the grass protruding through a crack in the stump. Whether the hawk constructed this nest, or whether it had been made by some other bird it is impossible to tell; but, if this hawk constructs no nest as asserted by Dr. Brewer and others, it must have obtained it piratically, as the nest was new. In another instance which occurred in Granby, Conn., the nest was known to have been obtained in this way. A farmer made a dove-house inside of his barn with holes through the sides of the building communicating with it. A pair of doves that had nested there were attacked and killed by a pair of sparrow hawks who took possession of their nest, laid four eggs and commenced to sit. During incubation they found the farmers' chickens very convenient for food—too much so for their own good. Both of the birds I saw after they were killed and their four eggs—two of

which are now in my cabinet. The eggs must have been sat upon several days; hence this was a full set. Samuels collected one set of four in Maine, and says in his ornithology "I am inclined to think from what I can learn from collectors and others, that four is the usual number laid by this bird." It is asserted by Audubon and others that the sparrow hawk raises two broods in a season in the southern states. Not having any personal knowledge of the fact, I wrote to my friend, Dr. S. W. Wilson, of Georgia, who is an experienced ornithologist and oologist, relative to this point. He says, that "the assertion of naturalists that birds south raise more than a single brood in the same season is certainly not applicable to the rapacious birds;" and again he says, "This is my experience after many observations, that none of the hawks and allied birds breed more than once during the same season," they begin nesting in Florida in February; in the middle states, in April; in Connecticut, in the latter part of April and the early part of May; in Maine, in May and June. A lad brought me a female sparrow hawk, April 26, 1871, which he shot on an old dead tree where he had seen it for several days. I inquired if he looked for a nest. "Yes," he replied, "I looked the tree all over and saw no nest on it." I told him to examine the holes in the tree. He returned the next day with two fresh eggs of this hawk. The set was incomplete but would have been full by the 1st of May. There is as much uncertainty about the age when this bird arrives at adult plumage as there is about the pigeon hawk's age — probably, three or more years. I do not know whether they nest before arriving at adult plumage. The hawk taken here with eggs, and the pair from Granby with eggs, were adult birds; these are the only specimens that I have received that I knew positively had nested.

Length, 10 to 12 inches — alar extent, 19 to 23 inches.

"Adult: Frontal band and space including the eyes and throat, white, spot on the neck behind, two others on each side of the neck, and line running downwards from before the eye, black. Spot on the top of the head, the neck behind, black; rump and tail light rufous or cinnamon color. Under parts generally a paler shade of the same rufous as the back, frequently nearly white, but sometimes as dark as the upper parts, and always with more or less numerous circular or oblong spots of black. Quills brownish black, with white bars on their inner webs. Tail tipped with

white, frequently tinged with rufous and with a broad subterminal band of black, outer frequently white, tinged with ashy and barred with black. Bill light blue, legs yellow. Back generally with transverse stripes of black, but frequently with very few or entirely without; rufous spot on the head, variable in size, and sometimes wanting.

Younger male: Upper parts as above; wing coverts and tail ferrugineous red, with numerous transverse bands of brownish black. Under parts with numerous longitudinal stripes, and on the sides with transverse bands of brownish black, external feathers of the tail palest, broad subterminal band on the tail obscure or wanting.

Young: All the rufous parts of the plumage with wider transverse bands of brownish black; wing coverts dark bluish cinereous, with large circular spots of black; under parts with longitudinal stripes, and large circular spots of black."

NATURE'S MEANS OF LIMITING THE NUMBERS OF INSECTS.

BY A. S. PACKARD, JR.

A FEW hints regarding the natural enemies of our injurious insects are here thrown together in order to call the attention of our naturalists and agriculturists to the subject, and provoke inquiries during the coming summer. There is no more interesting subject to our entomologists and ornithologists, than the relations between birds and insects, while the subject of rearing by the wholesale ichneumon and Tachina flies is of vital importance to agriculture.

In the first place I desire to correct a false impression I may have conveyed in my last entomological report to the Massachusetts Board of Agriculture regarding the relation of birds to the canker worm. I there remark that "it would seem as if the birds did not feed upon it to much extent." Wishing to examine into the matter more closely, I have in lack of observations of my

own, availed myself of the knowledge of some of our ornithologists.

I am indebted to Mr. C. J. Maynard of Ipswich for the following information upon the birds which devour the canker worm. He informs me that in the course of his investigations he has opened the stomachs of some three thousand birds.

"In answer to your questions relative to birds eating canker worms and the larvæ of other injurious insects I would say that upon examining my notes, I find that I have taken canker worms from the stomachs of the following species:—red-eyed vireo (*Vireo olivaceus*), song sparrow (*Melospiza melodia*), chickadee (*Parus atricapillus*), scarlet tanager (*Pyranga rubra*), robin (*Turdus migratorius*), black billed cuckoo (*Coccygus erythrophthalmus*), wood pewee (*Contopus virens*), least pewee (*Empidonax minimus*), Wilson's thrush (*Turdus fuscescens*), black and white creepers (*Mniotilta varia*), blue yellow-backed warbler (*Parula Americana*), Maryland yellow-throat (*Geothlypis trichas*), Nashville warbler (*Helminthophaga ruficapilla*), golden-crowned thrush (*Seiurus aurocapillus*), chestnut-sided warbler (*Dendroica Pensylvanica*), yellow warbler (*D. æstiva*), black and yellow warbler (*D. maculosa*), prairie warbler (*D. discolor*), black-polled warbler (*D. striata*), Canada warbler (*Myiodioctes Canadensis*), redstart (*Setophaga ruticilla*), cedar bird (*Ampelis cedrorum*), cat bird (*Mimus Carolinensis*), purple finch (*Carpodacus purpureus*), white winged crossbill (*Curvirostra leucoptera*), chipping sparrow (*Spizella socialis*), indigo bird (*Cyanospiza cyanea*), red-winged blackbird (*Agelaius phœniceus*), cow blackbird (*Molothrus pecoris*), bob-o-link (*Dolichonyx oryzivorus*), Baltimore oriole (*Icterus Baltimore*).

Possibly this list may be increased. Besides these birds, those species which occur in orchards during autumn and winter, such as the ruby-crowned wren, brown creeper, nuthatches and titmice, doubtless eat largely of the eggs of canker worms and other insects which destroy or injure the trees. Winter birds of the above species which I have shot at this time have their stomachs crammed with insects of some kind.

As I remarked to you the other evening the Baltimore oriole will eat largely of the tent caterpillar, and is the only bird which will do this.

All the thrushes will eat wire worms. The swallows destroy multitudes of dipterous insects (gnats, etc.). In fact to sum the matter up there is scarcely a bird which will not eat largely of insects at certain seasons, when these pests are most abundant.

It is a noticeable fact that many species inhabiting woods and meadows, as may be seen by the list given, leave their usual haunts and visit the fruit trees which are covered with canker worms and largely devour them.

In reference to the currant saw fly worm (*Nematus ventricosus*) I am not certain that I have seen any birds eat them, yet I think the truly insectivorous species will do this."

That the Baltimore oriole sometimes eats large quantities of the American tent caterpillar (*Clisiocampa Americana*), since they have been found in the stomach of this bird by Mr. Maynard, is an interesting fact, for birds as a rule do not relish hairy caterpillars, and the American tent caterpillar is covered with long hairs, though they are not so dense as in some other larvæ. In Europe the closely allied tent caterpillar (*C. neustria*), and those of the *Cnethocampa* and *Liparis chrysorrhœa* are said by Perris and others to be almost untouched by birds. I have been told by Dr. T. M. Brewer of Boston that the English sparrows upon the common devoured all the caterpillars of the tussock moth (*Orgyia*) which were injuring a fine tree. These caterpillars are very hairy, being adorned with pencils and tufts of long hairs.

Mr. John H. Sears, of Danvers, Mass., who has paid much attention to the habits of our birds, informs me that the cuckoo, which breeds near houses, is an exceedingly useful bird, as it devours the canker worms in large numbers. It is well that this should be known, as there is a popular prejudice against this bird, from its habit of sucking the eggs, as well as laying its eggs in the nests, of other birds. Among the birds which he has himself observed in the act of eating canker worms, are the king bird, the Baltimore oriole, the cat bird, the common flycatcher, the least flycatcher or wood pewee, the red eyed vireo and a few other small birds, such as certain warblers and flycatchers. The king bird in the month of May feeds on May beetles, as stated by Mr. J. L. Hersey, in this journal.

I also quote from a letter on the subject, for which I am indebted to Dr. T. M. Brewer: —

"The most noticeable of all the destroyers of the canker worm is the common cedar bird, which devours them to an extent perfectly enormous. Next is the purple grakle which also feeds on them as long as they last. The house pigeon, if in any numbers, is an invaluable bird. See, for instance, a garden corner of Summer and Chestnut streets, Salem, where the pigeons make canker worms a thing unknown. Among the other birds, all excellent so far as they go, are the chipping sparrow, the song sparrow, the purple finch, all the vireos, white-eyed, red-eyed, yellow-throated, solitary and warbling, the king bird, the cat bird, the downy wood-

pecker the summer yellow bird, Maryland yellow throat, the blue-bird. The bluejay eat their eggs in the winter, so does the chickadee. The latter eats their grub also and the worm too. The common gray creeper, which is with us only in the winter, eats the eggs.

Last summer I had a nest of golden-winged woodpeckers breeding on my place at Hingham. Some of them dug into my barn and passed the winter. Only a part of my trees were protected by a belt of printers' ink and some of them were partially eaten, but this winter very few grubs have as yet shown themselves, and I give my friend *Colaptes auratus* the credit of all this. I know this—I gave the young ones a lot of the worms myself and they eat them as if they were used to them. The old birds were too shy to permit me to see by their good deeds.

I think the golden robin feeds its young with them so long as they last, but I am not sure that they eat the tent caterpillar. I nearly forgot the two cuckoos, yellow-bill and black-bill. They eat every form of caterpillar, canker worms included. I do not think the robin feeds any to its young, because it would never do; they are too small and its brood want a big lot. I have known the robin to feed its young for entire days, as fast as they could bring them, with the moth of the cut-worm. That is about as much as we could expect of any bird to do at one time. At the rate they went, they must have caught and given their young ones about five hundred of these moths in a day. Before that, I had supposed the robin did me more harm than good, but I had to give in. My indebtedness to that pair was worth all the cherries I could raise in many years. So the robin and I are fast friends."

From the facts already presented, it may be inferred how useful birds may become in the work of reducing the number of injurious insects. Undoubtedly we have suffered greatly by our wanton killing of the smaller birds. We are far behind European nations in caring for the insect-eating birds, and providing nests for them about our houses and gardens. The Swiss and French, have been the most far-sighted in this matter of the protection of the smaller insectivorous species. The English, Scandinavians and Germans foster them, while in our country, teeming as it is with hosts of ravaging insects, the smaller birds are hunted and persecuted, or if let alone, there is no effort made on any extended scale to invite them to our houses and gardens.

In this connection I may refer to the barbarous and thoughtless custom of our young men, in the autumn, organizing in companies and shooting small quadrupeds and birds. These hunting parties destroy large numbers of raccoons, foxes, skunks, mink, weasels

and squirrels. It is well known that the skunk, if not an entirely inoffensive animal, is exceedingly useful. Its food consists mainly of insects, and those among the most injurious, such as the May beetle or dorbug. Mink and weasels eat insects, and squirrels as I am told, besides eating nuts, will in times of hunger eat the chrysalides of insects. It is known that all the smaller quadrupeds, even the fox, will eat insects when other food is wanting.

It is said that little harm results from shooting birds in autumn, as the breeding season is over, and the birds are migrating southward, but in the southern states they will prove as useful to agriculture there during their long winter residence, and it is a selfish policy that would injure the prosperity of farmers in one section of the country, merely to afford a day's barbarous pleasure to the inhabitants of another. Those birds which are shot in considerable numbers at such times, as partridges and quail, are insectivorous as well as vegetarians, and of late years the quail has been known to render essential service in consuming the Colorado potato beetle.

In fact this indiscriminate slaughter of small quadrupeds and birds tends to destroy the balance of nature. That there is a law of equilibrium in the distribution of the numbers of animals may be seen on a moment's examination of well known facts. The codfish is known to lay several hundreds of thousands of eggs, and yet such is the destruction of life, that few of the eggs are left untouched by other animals; and of the young that hatch, it may be safely said that only a pair of adult fish remain. Only two eggs of the original hundreds of thousands result in accomplishing the end for which so many were laid. So among the insects. The queen bee is known sometimes to lay during her whole life more than a million eggs; during the height of the breeding season, under the most favorable circumstances, laying from two thousand to three thousand eggs, and yet how slight is the increase in the numbers of the honey bee. It would be an interesting study to trace out the causes that cut short the lives of so many bees. Then look at the aphides or plant lice, with their anomalous virgin-reproduction, by which the young are produced like the buds on a tree. One virgin plant louse was found by Bonnet to bring forth on an average about one hundred young, and so on for ten generations: now add up the number of young produced by those of, say, ten broods, and we have the enormous number of 1,000,000,000,000,

or a quintillion young—all descendants of one spinster plant louse. Says Professor Huxley in commenting on this fact, "I will assume that an aphis weighs $\frac{1}{1000}$ of a grain, which is under the mark. A quintillion will on this estimate weigh a quadrillion of grains. He is a very stout man who weighs 2,000,000 grains; consequently the tenth brood alone, if all the members survive the perils to which they are exposed, contains more substance than 500,000,000 stout men, to say the least, more than the whole population of China."

When we realize that so far from a quintillion, only a pair or two of plant lice survive, and at the end of the season die, after laying a few eggs, by which the species is represented in winter, we can form some idea of the struggle for existence among animals, and of the vicissitudes to which they are exposed. We can see how delicate is the balance of circumstances by which nature preserves the equilibrium, seeking, as it were, on the one hand to prevent the extinction of the species, and on the other its undue multiplication.

Now birds are an important agency in restraining the increase of species injurious to man. Yet this aid is blind and impartial. They devour useful as well as injurious insects. They sometimes eat our fruits, even if they overbalance the mischief by a strict adherence to insect diet out of the short fruit season. It follows that we must depend more upon an intimate knowledge of the habits of the birds themselves.

M. Perris in an admirable paper in the "*Mémoires de la Société Royale des Science de Liége*" (tome iii, 1873) entitled "*Les Oiseaux et les Insectes*" says:

"Almost all birds, probably even the whole of them, eat insects. Even the birds of prey, when they are an hungered, accept this makeshift, as do also, according to M. Florent Prèvost, the wolf, the fox and the badger, when they have not been fortunate in the chase. There are some birds, such as the swallows, the martins, the goatsuckers, which live exclusively on insects; others, as the nightingale, the warblers and all the birds with small beaks, which habitually consume insects, and only change their habits at the latter end of autumn, then eating berries, figs, etc.; others such as the chaffinch, the goldfinch, the sparrow, which in rearing their young prefer insects to grain, and which for the rest of the time, prefer grain to insects. Still others, for example the magpie, are omnivorous: insects, worms, larvæ, grains, fruits, small birds, small chickens, all are welcome. Finally, not to prolong this

enumeration, for we should never finish if we mentioned all, the rapacious birds, such as the screech owl, the buzzard, the kite, more accustomed to live on flesh, are sometimes forced to content themselves with a morsel less succulent and less appropriate to their taste. From this very succinct and very incomplete résumé of the manner in which birds live, but which every one can extend and complete, it follows from the great number of birds that there is daily an immense destruction of insects. It is not by thousands only, but by hundreds of thousands, by millions, according to the area embraced, that we should count in fine weather and from one sunny day to another, the number of victims. The imagination shrinks at the idea of the total to which we should reach at the end of a year."

Mr. Perris then says, the main question is, How many of the insects thus eaten are injurious? We will quote our author's conclusions, though we think that in desiring to show that the protection and culture of birds are not the only way to prevent the attacks of injurious insects, as many of his countrymen think, he is a little disposed to underrate on his side their importance, which is felt in this country especially, in dealing with injurious caterpillars, such as the tent caterpillar, canker worm and the bud worm (*Penthina oculana*) of the apple and the pear, which would otherwise annihilate our apple and pear crop, as they almost threaten to do now. Remarks M. Perris:—

1. "Birds are only united in troops more or less considerable at the times of migration of autumn and spring, that is to say when most insects are infinitely less numerous than during the summer. The rest of the time, they live ordinarily in couples apart by themselves, quite rare in cultivated grounds, while the insects invade *en masse* the trees they wish to attack, the crops of which they are the enemies.

2. "Birds destroy insects enormously, but these insects are in great part neutral; some are eminently useful, and the species really injurious, compared to the whole, are scarcely at all reduced in numbers, as the birds, in consuming these little creatures, do not serve particularly our interests; they even injure us, many of them devouring our fruits as well as seeds either planted in the soil, or harvested, and especially in suppressing the carnivorous or parasitic kinds which render us great service.

3. "The insects of which we have the most to complain are either large enough to defy the birds, or (and these are the most formidable) too small to draw their attention; some of them taste too badly to excite their appetite; many are nocturnal and hide by day, with that instinct of self-preservation which is as much developed in them as in the larger animals; or, living inactive, they

do not reveal themselves to the eye of the bird, which perceives more easily and follows more willingly the insects which fly or move about. Some live under earth or in homes of their own; all are endowed with a fecundity which astonishes the imagination and which, in every case, is such that man, in spite of assiduous and persevering care, cannot even in a small farm, rid himself of them, nor often even free his house of them, not even a portion of it.

4. "The grubs and caterpillars, which are more especially the authors of the damages, live almost entirely concealed under the soil, under bark, deep in the road, in the stems of plants, in fruits, in inhabited places, under silken nets, and only pay the birds a very feeble tribute. Those which are developed in the open air are generally hairy, which repels birds; certain of them are nocturnal and disappear before day; others are protected by their excessive smallness."

Perris in another place enumerates other useful animals, and his remarks will apply in the main to this country:—

"There are among the mammalia, the moles, which without doubt do some mischief in covering our fields with mole hills . . . . . but they benefit us by destroying many insects and injurious grubs which live under the surface of the soil; besides the hedgehogs, the field mice, the great-headed field mouse (campagnol), the shrew mice, the bats, which are the more useful, in that they are nocturnal."

He also enumerates certain birds, and the larger number of the reptiles, adders, the blind worm, lizards, frogs, rennets, toad and turtle. The toads are of especial value as their only diet appears to be flies and grasshoppers and other insects. These animals are extremely sedentary. Wherever they find a supply of insects there they will remain for weeks at a time, as long as the supply lasts. On Penikese island, some of the students of the Anderson School of Natural History discovered that the stomachs of the numerous toads there were filled with young grasshoppers, and that they even hopped down to the shore and fed upon the beach-fleas which live under sea-weed between tide-marks. Toads are doubtless of use in devouring canker worms, as they abound under apple trees infested by them, and probably devour large quantities when the worms descend in June to the earth in order to undergo their transformation into the chrysalid state. It would be worth while to collect them in large numbers and place them in gardens and orchards, as once deposited there, they will remain.

Before I leave this subject of the agency of birds and other vertebrate animals in maintaining this equilibrium in the numbers

of injurious and beneficial insects, I would urge the importance of a carefully conducted series of observations by some of our practical ornithologists and entomologists working in conjunction. From May until October one or several specimens of our most common insectivorous birds, as well as those occasionally so, should be daily collected, the time and nature of the day noted, and a list made of the species of insects found in their stomachs, the number of specimens, with other remarks. From the data thus collected we shall be able to form an intelligent opinion as to the vexed question, how far the birds devour indiscriminately injurious and beneficial insects; and I venture to predict that it will be found that the number of ichneumon and other beneficial kinds will form such a minimum as will be quite unimportant.

By far the most important agency in nature, and one almost incalculable in its effects, is the warfare of insects upon each other. We have seen how wonderfully fertile is the plant louse, though it may not lay an egg. Now the immense powers of multiplication of individuals in this and all other insects are held in check by carnivorous insects. One-half of the insects make war upon the other half. Insects attack one another in various ways, either by the stronger directly devouring the weaker; or as parasites they still more surely and effectually perform the work of destruction.

Among the external though less known enemies belonging to the order of beetles, which Perris enumerates from his extended observations on their habits, are a large number which live under the bark of trees. I quote his accounts of them, premising that we have similar insects with like habits in this country; and though the list of scientific names seems formidable, yet there are no common names for them. I use nearly his own words, with occasional interpolations of English names.

"When one of the Scolytids injurious to pines (the *Bostrichus stenographus*) lays its eggs under the bark, the *Platysoma oblongum* introduces itself by the hole which has given entrance to the first named insect, it lays its eggs in the gallery of the Bostrichus, and from those eggs are born the carnivorous larvæ which devour those of the wood-eating beetles. Other beetles conduct themselves in the same manner in warring against other Scolyti. The larvæ or grubs of *Plegaderus discisus* destroy the young of *Crypturgus pusillus;* another wood-eating beetle, the *Aulonium sulcatum*, is the deadly enemy of *Scolytus destructor*, so formidable a foe to shade trees; *Aulonium bicolor* attacks *Bostrichus laricis; Colydium*

bicolor preys upon the Bostrichus of the larch; *Colydium elongatum* on *Platypus cylindrus*, *Rhizophagus depressus* on *Blastophagus piniperda* and *B. minor*, *Lœmophlœus hyperbori* on *Hyperborus ficus*, *Hypophlœus pini* on *Bostrichus stenographus*, and finally *Hypophlœus linearis* on *Bostrichus bidens*. Who will not be struck by these antagonisms? Who will not admire this infallibility of instinct which causes these insects to discover the tree attacked, and perceive, among the species which the tree conceals, the victim which has been assigned to them?"

"Other beetles exhibit the same sagacity. The larvæ of several Elaterids (wire worms) and those of *Clerus mutillarius* and *formicarius* make war on those of some longicorn beetles of the oak, the elm, alder bush and the pine. The *Opilus mollis* and *domesticus* are the enemies of the borers which mine our floors and ceilings; the *Cylidrus albofasciatus* and the *Tillus unifasciatus* prey on *Synoxylon sexdentatum* and on *Xylopertha sinuata* which seek the diseased branches of the vine, and those of several trees; the *Tarsostenus univittatus* attacks the *Lyctus canaliculatus*, injuring our timber works; while the *Trogosita Mauritanica* destroys the grain moth."

We would also add among other efficient laborers in the cause of agriculture the lady birds, lace-winged flies, Syrphus flies and numerous wasps. But the true parasites, the ichneumon and Tachina flies, those which live within the bodies of vegetable-eating insects, these are the aids which beyond all other influences keep in check the noxious kinds. It may be said that each sort of caterpillar has its peculiar ichneumon parasite, and some are known to have several. Here we have an engine of destruction which man can in some measure direct. We have seen that birds eat friend and foe indiscriminately. The great practical question in applied entomology is how can man breed and disseminate these insects, and use them as most potent instruments of warfare against insect depredators. This question has been satisfactorily settled for the first time by Dr. W. LeBaron, the State Entomologist of Illinois. So important and suggestive are his remarks that I quote the whole chapter on "The transportation of useful parasitic Insects" from his able report for 1873, as it deserves the widest dissemination among thinking agriculturists.

"The idea of rearing the useful parasitic insects, and of transporting them, when necessary, from one part of the country to another, has often presented itself to practical entomologists, and was a favorite topic of speculation of my predecessor in office, B. D. Walsh. But the very small size of most of these insects, many

of them, indeed, being so minute that they cannot easily be seen without the aid of a lens, and the constant difficulty of manipulating them have always given a somewhat chimerical aspect to the suggestion, and have caused it to be regarded as more ingenious than practicable.

"In the course of our investigation of the oyster-shell bark louse of the apple tree, in the year 1870, we discovered a minute chalcis fly, which we designated as the chalcideous parasite of the oyster-shell bark louse, *Chalcis* (Aphelinus) *mytilaspidis*, which was found to be extensively instrumental in extirpating that deadly enemy of the apple tree, by boring into the scale and depositing her own eggs in the body, or in the midst of the eggs of the bark louse. The parasitic larvæ which hatched from this egg lived at the expense of the bark louse and its eggs, and thus caused their destruction. It was found that in several of the counties of this state where the examinations were made, that more than half of the bark lice had been destroyed by this parasite, its operations being known, partly by the presence of the little grubs beneath the scales, and partly by the minute round holes in the scales, through which the chalcis flies had escaped. It was also found, by examining the scale, late in the fall, that one brood of the chalcides hibernated in the larva state beneath the scales. The idea, therefore, readily occurred that this was a very favorable opportunity for testing the practicability of transporting these friendly parasites to those parts of the country in which their presence cannot now be detected. We had previously received several packages of apple twigs from different localities in the northern part of Illinois and the southern part of Wisconsin, heavily infested with the scales of the bark louse, but without any traces of the parasitic chalcides, and this section of country seemed therefore to furnish a favorable field in which to try the experiment of colonization.

"Captain Edward H. Beebe, of Galena, who had been passing the winter in Geneva, and who had taken a lively interest in this investigation, undertook to conduct this interesting experiment. Early in the spring of 1871, on his return to Galena, he took a package of twigs, which we had procured from trees known to have been inhabited by the chalcides, and under some of the scales upon which it was therefore probable that the larvæ were hibernating. These he tied upon trees in three different orchards, in the town of Galena, which were known to be badly infested by bark lice.

"When we consider the minute size of these insects, the fully matured fly (Fig. 72) being only one twenty-fifth of an inch in length, and that the hole in the scale of the bark louse which reveals the operation of the chalcis is so minute that it can only be seen by the aid of a magnifying glass; and we further take into account that probably less than a dozen of these larvæ were transported to the new locality, and that the small number of parasitic

flies proceeding from these were let loose in three orchards containing many hundreds of apple trees, we may form some idea of the difficulties of this experiment, and of the uncertainty which would be likely to attend any observations made for the purpose

Fig. 72.

Aphelinus of the Apple Scale Insect.

of determining the presence of the chalcides. Even if the experiment should prove ultimately successful, it would be very doubtful whether the chalcis marks would be sufficiently numerous to be detected at the close of the first year, but after this they would be likely to multiply in a rapidly increasing ratio.

"About the last of May, 1872, that is, after the intervention of one year from the time of commencing this experiment, Capt. Beebe examined some of the trees to which the chalcis twigs had been attached, and after a careful search thought that he had discovered a few traces of the operations of the chalcides, and sent half a dozen of the twigs bearing these marks to me for inspection. . . . . On the 13th of July, I visited Galena and, in company with Capt. Beebe, submitted one of the trees, to which the greatest number of the twigs had been attached, to a thorough examination.

"The result, if not actually conclusive, was at least extremely encouraging. We detected a considerable number of holes in the scales, which appeared to be identical, in every respect, with those made by the chalcis in question, and in one instance we discovered three of these holes upon the same twig, within a space of four inches.

"In conducting an experiment of so delicate a nature I am well aware that the greatest caution must be exercised to avoid jumping to hasty conclusions, and that the observations of a number of succeeding years will be necessary before we can arrive at a definite conclusion that the experiment has been followed by a practical as well as scientific success.

"At the close of the author's article upon the oyster-shell bark louse, in his first annual report, after speaking of the absence of any signs of the chalcides, in the northernmost part of the state, and of the possible practicability of transporting them thither, we concluded with the following remark: 'The absence of the chalcis of the bark louse, in this locality, will furnish an excellent opportunity for testing the practicability of transporting it thither

from those places where it is known to exist. If, after taking the preliminary steps, as described in a former part of this article, we should find, after the lapse of the necessary time, upon the trees experimented with, the characteristic holes in the scales which mark the exit of the chalcis, we should know that the friendly parasite had entered upon its work. If such an experiment could be conducted to a successful issue, it would furnish one of the most admirable instances on record, of the triumph of science, in its application to economic entomology.'"

In like manner the Hessian fly and wheat midge could, we believe, be kept within legitimate bounds, by the transportation from Europe of the parasites that in England and France are known to reduce their numbers materially. It would be an easy task to cause several bags of stubble containing the cocoons of these parasites to be sent over to this country, and reared here. So also the dreaded cabbage butterfly, our last European importation, can in new districts be kept under by transporting the Pteromalus or chalcis parasite, which in Essex county, Mass., is quite abundant. This rearing of ichneumon parasites can be carried on by intelligent gardeners and farmers in conjunction with an entomologist, and we look upon the future of ichneumon culture as one of the departments of a scientific, intelligent agriculture. Something should be done in the matter by the national department of agriculture, and instead of disseminating frightfully injurious insects in the seeds distributed from Washington, as is sometimes done through carelessness, it would be less harmful to scatter broadcast papers of ichneumon seed.

HABITS AND CHARACTERISTICS OF SWAINSON'S BUZZARD.

BY DR. ELLIOTT COUES, U. S. A.

THIS large hawk is very abundant in northern Dakota, where it came under my observation almost daily during the summer of 1873. Excepting an occasional rough-leg or red-tail, it was the only buteonine species observed, and the only hawks more common were the ubiquitous marsh harriers and sparrow-hawks.

The species is thoroughly distinct from its nearest ally, *B. borealis;* it never gains the red tail, so characteristic of the latter, and differs in other points of coloration in its several stages of plumage, as noted beyond. Although its linear dimensions intergrade with those of the red-tail, it is not so heavy nor so large a bird, and its shape differs in some points. A tangible and very convenient distinction, to which my attention was first called by Mr. Ridgway, and which I have verified in numerous instances, is found in the emargination of the primaries. As stated in my late work (Key N. A. Birds, p. 217), Swainson's buzzard has only *three* emarginate primaries, while the red-tail has *four;* the fourth quill of the former, like the fifth of the latter, is variously sinuate-tapering, but never shows the decided nick or emargination of the inner web.

The following measurements, taken in the flesh, illustrate the sexual difference and other variations in size: Largest adult ♀ 22 inches long, 54 in extent, the wing 16; other females respectively 21·50×51·75×16·25. . . . 21·00×53·00×15·75. . . . 20·50×51·00×15·25. . . . 19·00×49·00×13·50; but this last one was an ungrown young. Adult ♂ 19·00 to 20·00 long, by about 49·00 in spread of wing, the latter 15·00 and a little more. In both sexes, and at all ages, the eye is brown, but of varying shade—I have seen no approach to a yellow iris. In the old birds the feet, together with the cere, gape, and base of under mandible are rich chrome yellow; the rest of the bill, and the claws, being bluish black. In the young of the year these yellow parts are much duller—grayish-yellow, or yellowish clay-color. Most of the old birds I have skinned had the integument of the lower belly largely bare, yellowish in color, hardened and thickened with warty excrescences; this disease seemed the rule rather than the exception. Unfledged nestlings are covered with white fluffy down; the first feathers to appear on the under parts show the characteristic color and markings of the formerly supposed species, "*B. Bairdii.*" (The various plumages are given beyond.) A moult occurs in August and September; it is protracted, the feathers being very gradually renewed, almost one by one; the fresh heavily colored feathers contrasting strongly with the ragged and faded ones worn during the summer. The young have no moult at this season, carrying the plumage in which they leave the nest into the winter. I have no observations upon a spring moult which

probably occurs to both old and young. I took no specimens in the melanistic state of plumage in which the bird has been described as another supposed species—*B. insignatus;* and only saw one in which the entire under parts looked as dark, when the bird was sailing over me, as the pectoral band of the adults is. This dark plumage appears to be an individual peculiarity, not a normal stage of regular occurrence.

Swainson's buzzard may be seen anywhere in the region mentioned—even far out on the prairie, miles away from timber, circling over head, or perched on the bare ground. In alighting, it generally takes advantage of some little knoll commanding a view around, though it often has no more prominent place than the cart-load of dirt from a badger's hole, from which to cast about for some imprudent gopher* espied too far from home, or still more ignoble game. But the bird prefers timber, and, especially as its nesting is confined to trees, it is most frequently observed in the vicinity of the few wooded streams that diversify the boundless prairie. In northern Dakota such streams cut their tortuous way pretty deeply into the ground, and the sharp edges of the banks, rising steep on one side and on the other stretching away on a continuous level, are favorite resting spots, where sometimes a line of several birds may be observed strung along a distance of a few yards. The Souris or Mouse River, a stream of this description, is a favorite resort, where I found the birds more numerous than anywhere else. Much of the river bottom is well wooded with elm, oak and other large trees; and the number of nests found in this timber—sometimes several in sight of each other—would be considered surprising by one not recollecting that conveniences for breeding are in this country practically limited to such narrow tracts.

The nests are built at varying heights, from the intricacies of heavy shrubbery where a man may reach them from the ground, to the tops of the tallest trees. They are generally, however, placed thirty or forty feet high, in some stout crotch or on a horizontal fork. They are bulky and ragged looking structures, from the size of sticks used for the base and outside; the interior is composed of smaller twigs more compactly arranged. The shape

* "*Gopher*": Frontier vernacular name for all the ground-squirrels (*Spermophili*) indiscriminately. *S. tridecem-lineatus* is the commonest kind here. The pouched rats are known as "pocket-gophers."

varies with the requirements of the location, being more or less conical in an upright crotch, flatter on a fork. The interior hollowing is slight. An average external diameter may be given as two feet, and depth half as much. I was too late for eggs in the locality above mentioned; the only nest I found with anything in it contained two half-fledged young. This was on the 15th of August—so late as to induce the belief that perhaps two broods may be reared in a season, especially as before this date I had observed many full grown yearlings on the wing. This nest built about forty feet high, in an oak tree, was very untidy, matted inside with excrement and the scurfy exfoliation from the growing feathers of the youngsters, and encumbered with portions of several gophers. The nestlings were too young to make any resistance beyond a menacing hiss and a very mixed flapping when they were unceremoniously pitched out. The mother was shot near the nest with a pistol-ball, but her partner kept prudently out of the way. This bird had not reached her mature plumage. The young had been well cared for; their crops were full of gopher-meat at the time, and they were very fat.

In July, I had a live young one in captivity, at about the age of these two; and early in August, I possessed a completely feathered and full grown bird of the year, probably hatched in May. This shows that either two broods are reared, or that the laying season runs through most of the summer. This grown young one made rather an acceptable capture for some days, as he was trim and shapely, with a fine eye and general military bearing, as well as an excellent appetite. But then he was bad-tempered, took the most civil advances unkindly, and would not even fraternize with a pair of very well disposed and sensible owls that were picketed with him. At last, when he so totally failed to appreciate his position as to use his claws with painful effect, he was summarily executed. Both this and the younger one before him had a peculiarly plaintive whistle to signify hunger or a sense of loneliness, a note that was almost musical in intonation. This was the only cry I heard from them; the old birds have the harsh loud scream, much alike in all our large hawks.

The quarry of Swainson's buzzard is of a very humble nature. I never saw one stoop upon a wild-fowl or grouse, and though they probably strike rabbits, like the red-tails, their prey is ordinarily nothing larger than gophers. Though really strong and sufficiently

fierce birds, they lack the "snap" of the falcons and asturs; and I scarcely think they are smart enough to catch birds very often. I saw one make the attempt on a lark-bunting. The hawk poised in the air, at a height of about twenty yards, for fully a minute, fell heavily with an awkward thrust of the talons—and missed; the little bird slipped off badly scared no doubt, but unhurt, while the enemy flapped away sulkily, very likely to prowl around a gopher-hole for his dinner, or take potluck at grasshoppers. They procure gophers, mice and other small quadrupeds both by waiting patiently at the mouth of the holes, ready to claw out the unlucky animals the moment they show their noses, and by sailing low over the ground to pick up such as they may find away from home. But I question whether, after all, insects do not furnish their principal subsistence. Those that I shot after midsummer all had their craws stuffed with grasshoppers. These insects, which appear sometimes in almost inconceivable numbers, seem to be the natural source of supply for a variety of animals. Wolves, foxes, badgers, and even the rodents, like gophers, supposed vegetarians, come down to them. Sandhill cranes stalk over the prairie to spear them by thousands. Wild-fowl waddle out of the reedy pools to scoop them up; we may kill scores of sharp-tailed grouse, in September, to find in every one of them a mass of grasshoppers, only leavened with a few grubs, beetles leaves, berries and succulent tops of plants. It is amusing to see a hawk catching grasshoppers; skipping about "like a hen on a hot gridiron," in an awkward way, and looking as if he were rather ashamed of being seen in such a low performance. Food being so abundant and easily procured, the birds become extremely fat early in the autumn, and lazy withal. Unaccustomed to the presence of man in these regions, they may be approached with little difficulty as they perch on the trees, and often fly unwittingly within short range. When brought down winged they show no lack of spirit, and must be prudently dealt with, as their talons are very effective weapons of defence.

Changes of plumage with age affect more particularly the under parts, the back, wings and tail being more nearly alike at all times.

Young-of-the-year (both sexes). Entire upper parts dark brown, everywhere varied with tawny edgings of the individual feathers. The younger the bird, the more marked this variegation; it corresponds in tints closely with the color of the under parts, being palest in very young examples.

Under parts, including lining of wings, nearly uniform fawn-color (pale dull yellowish-brown), thickly and sharply marked with blackish-brown. These large dark spots, for the most part circular or guttiform, crowd across the fore breast, scatter on the middle belly, enlarge to cross-bars on the flanks, become broad arrowheads on the lower belly and tibiæ, and are wanting on the throat, which is only marked with a sharp narrow blackish pencilling along the median line. Quills brownish-black, the outer webs with an ashy shade, the inner webs toward the base grayish, paler and marbled with white, and also showing obscure dark cross-bars; their shafts black on top, nearly white underneath. Tail feathers like the quills, but more decidedly shaded with ashy or slate gray, and tipped with whitish: their numerous dark cross-bars show more plainly than those of the quills, but are not so evident as they are in the old birds.

Adults (either sex). Upper parts dark brown, very variable in shade according to season or wear of the feathers, varied with paler brown, grayish or even reddish brown edgings of the feathers, but without the clear fawn color of the young: the feathers of the crown showing whitish when disturbed, and usually sharp dark shaft lines; the upper tail coverts chestnut and white with blackish bars. Quills and tail feathers as before, but the inner webs of the former showing more decided dark cross-bars upon a lighter marbled-whitish ground; and the latter having broader and sharper dark wavy bars. These large quills, particularly those of the tail, vary much in shade according to wear, the new feathers being strongly slate-colored, the old ones plain dark brown. The tail, however, never shows any trace of the rich chestnut that obtains in the adult *B. borealis*. *Male:* Under parts showing a broad pectoral area of bright chestnut, usually with a glaucous cast and displaying sharp black shaft lines; this area contrasting sharply with the pure white throat. Other under parts white, more or less tinged and varied, according to age, with light chestnut. In the oldest males, this chestnut is diminished to traces, chiefly in flank-bars and arrowheads, and the white throat is immaculate; in less mature examples, throat shows blackish pencilling, and the rest of the under parts are so much marked with chestnut, chiefly in cross-bars, that this color predominates over the white, and appears in direct continuation of the pectoral area itself. Some feathers of this area are commonly dark brown. *Female:* Much darker underneath than the male; throat pure white, but other under parts probably never whitening decidedly. Pectoral from rich dark chestnut or mahogany color, mixed with still darker feathers, to brownish-black, and other under parts heavily marked with chestnut, chiefly in cross-bars alternating with whitish, but on the flanks, and sometimes across the belly, these markings are quite blackish. The general tone of the under parts may be quite as dark as the pectoral area of the male; but it lacks uniformity, and the increased depth of color of the pectoral area in this case suffices to preserve the strong contrast already mentioned.

FOSSIL HORSES IN AMERICA.

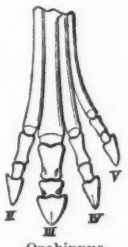
BY PROFESSOR O. C. MARSH.

It is a well known fact that the Spanish discoverers of America found no horses on this continent, and that the modern horse (*Equus caballus* Linn.) was subsequently introduced from the old world. It is, however, not so generally known that these animals had formerly been abundant here, and that long before, in Tertiary time, near relatives of the horse, and probably his ancestors, existed in the far west in countless numbers, and in a marvellous variety of forms. The remains of equine mammals, now known from the Tertiary and Quaternary deposits of this country, already represent more than double the number of genera and species hitherto found in the strata of the eastern hemisphere, and hence afford most important aid in tracing out the genealogy of the horses still existing.

The animals of this group which lived in this country during the three divisions of the Tertiary period were especially numerous in the Rocky Mountain regions, and their remains are well preserved in the old lake basins which then covered so much of that country. The most ancient of these lakes—which extended over a considerable part of the present territories of Wyoming and Utah—remained so long in Eocene times that the mud and sand, slowly deposited in it, accumulated to more than a mile in vertical thickness. In these deposits, vast numbers of tropical animals were entombed, and here the oldest equine remains occur, four species of which have been described. These belong to the genus *Orohippus* Marsh, and are all of diminutive size, hardly larger than a fox. The skeleton of these animals resembled that of the horse in many respects, much more indeed than any other existing species, but instead of the single toe on each foot, so characteristic of all modern equines, the various species of *Orohippus* had four toes before and three behind, all of which reached the ground. The skull, too, was proportionately shorter, and the orbit was not enclosed behind by a bridge of bone. There were forty-four teeth in all, and the premolars were smaller than the molars. The crowns of these teeth were very short. The canine teeth were

developed in both sexes, and the incisors did not have the "mark" which indicates the age of the modern horse. The radius and ulna were separate, and the latter was entire throughout its whole length. The tibia and fibula were distinct. In the fore foot, all the digits except the pollex, or first, were well developed, as shown in the accompanying figure (73) of the left fore foot of *Orohippus agilis* Marsh. The third digit is the largest, and its close resemblance to that of the horse is clearly marked. The terminal phalanx, or coffin bone, has a shallow median groove in front, as in many species of this group in the later Tertiary. The fourth digit exceeds the second in size, and the fifth is much the shortest of all. Its metacarpal bone is considerably curved outward. In the hind foot of this genus, there are but three digits. The fourth metatarsal is much larger than the second.

Fig. 73.



Orohippus agilis.

The only species of *Orohippus* at present known are from the Eocene of Wyoming and Utah, and are as follows:—*Orohippus gracilis* Marsh, *O. pumilus* Marsh, *O. agilis* Marsh, and *O. major* Marsh.*

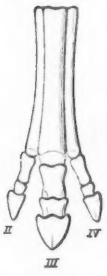
In the middle Tertiary, or Miocene, there were two other lakes on either side of the great Eocene basin. The largest of these was east of the Rocky Mountains, extending over portions of what are now Dakota, Nebraska and Colorado. The clays deposited in this lake form the "*Mauvaises terres*," or "Bad lands," of that region, and are well known for their fossil treasures. The other Miocene lake was west of the Blue mountains, where eastern Oregon now is, but its extent is unknown, as this whole region has since been covered with a vast sheet of basalt, a thousand or more feet in thickness, and the original lake sediments are only to be seen where this lava has been washed away. In both of these ancient lake basins, many remains of animals allied to the horse are found, showing that during the Miocene this group of mammals were well represented.

In the western, or Oregon basin, the genus *Miohippus* Marsh first makes its appearance. It resembles *Orohippus* of the Eocene in its general characters, especially in the shape of the skull, number and form of teeth, and separate ulna; but it had

* American Journal of Science, Vol. vii, p. 247, March, 1874.

only three toes in the fore foot, as well as behind, and the fibula was coössified with the tibia at its lower end. In this genus, all the toes reached the ground, as shown in the accompanying figure of the left fore foot of *Miohippus annectens* Marsh, the type species (Fig. 74). In the same deposits, the genus *Anchitherium* Meyer occurs, represented by a single species, *A. anceps* Marsh. This genus is closely allied to *Miohippus*, but differs in having a deep depression in the skull in front of the orbit. The radius and ulna are united, and the outer toes are reduced in size. In the eastern basin, *Anchitherium Bairdi* Leidy is abundant, and with it is found a smaller species, *A. celer* Marsh. The animals of these two genera are all larger than the species of *Orohippus* from the Eocene, some of them exceeding a sheep in size. The Miocene species known with certainty are as follows:—*Miohippus annectens* Marsh, *Miohippus Condoni* (*Anchitherium Condoni* Leidy) and *Anchitherium anceps* Marsh, from Oregon; and *A. Bairdi*, Leidy, and *A. celer* Marsh, from the eastern basin.

Fig. 74.



Miohippus annectens.

During the Pliocene, or later Tertiary, a great development of the horse family took place, and vast numbers of these animals left their remains in the lake deposits of that epoch. The largest of these lakes had the Rocky Mountains for its western border, and extended from Dakota to Texas, its northern part covering the bed of the older Miocene basin. Another Pliocene lake, of unknown limits, extended over the older Tertiary strata of eastern Oregon, and evidence of still others may be seen in Idaho, Nevada and California. In all of these basins, equine remains of various kinds have been found, but the most important localities are the region of the Niobrara river east of the mountains, and the valley of the John Day river in Oregon.

The equine genera of the Pliocene which appear to be most nearly related to their predecessors from older strata are, *Anchippus* Leidy, *Hipparion* Christol, and *Protohippus* Leidy, all three-toed forms, but with the outer digits reduced to much the same proportions as the posterior hooflets of the modern deer and ox. The genus *Pliohippus* Marsh, from the same deposits, had feet like those of the recent horse. Other genera, less known, which have been proposed, are *Parahippus*, *Merychippus*, and *Hypohippus*

of Leidy, to whose researches we are so largely indebted for our present knowledge of this group. Of these Pliocene genera, more than twenty species have been described from American strata, all apparently larger than their Miocene relatives, but all smaller than the present horse, and many of them approaching the ass in size. Among the more characteristic of these species may be mentioned, *Anchippus Texanus* Leidy, from Texas; *A. brevidens* Marsh, from Oregon; *Hipparion occidentale* Leidy, and *H. speciosum* Leidy, from Nebraska; *Protohippus perditus* Leidy, from the Niobrara; *P. parvulus* Marsh, from Nebraska, the smallest Pliocene species; *Parahippus cognatus* Leidy, and *Pliohippus pernix* Marsh, from the Niobrara.

In the upper Pliocene, or more probably in the transition beds above, there first appears a true *Equus*, and in the Quaternary deposits, remains of this genus are not uncommon. Five or six species are known from the United States, and several others from Central and South America. The latest extinct species appears to have been *Equus fraternus* Leidy, which cannot be distinguished anatomically from the existing horse. These later extinct horses are all larger than the Pliocene Equines, and some of them even exceeded in size the living species.

The large number of equine mammals now known from the Tertiary deposits of this country, and their regular distribution through the subdivisions of this formation, afford a good opportunity to ascertain the probable lineal descent of the modern horse. The American representative of the latter is the extinct *Equus fraternus* Leidy, a species almost, if not entirely, identical with the old world *Equus caballus* Linn., to which our recent horse belongs. Huxley has traced successfully the later genealogy of the horse through European extinct forms,* but the line in America was probably a more direct one, and the record is more complete. Taking, then, as the extremes of a series, *Orohippus agilis* Marsh, from the Eocene, and *Equus fraternus* Leidy, from the Quaternary, intermediate forms may be intercalated with considerable certainty from the thirty or more well marked species that lived in the intervening periods. The natural line of descent would seem to be through the following genera: — *Orohippus*, of the Eocene; *Miohippus* and *Anchitherium*, of the Miocene; *Anchippus*,

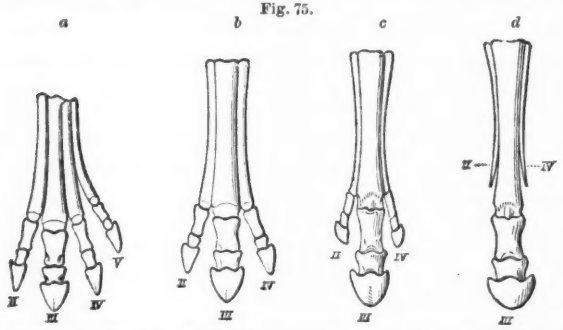
* Anniversary Address, Geological Society of London, 1870.

Hipparion, *Protohippus* and *Pliohippus*, of the Pliocene; and *Equus*, Quaternary and recent.

The most marked changes undergone by the successive equine genera are as follows: 1st, increase in size; 2d, increase in speed, through concentration of limb bones; 3d, elongation of head and neck, and modifications of skull. The increase in size is remarkable. The Eocene *Orohippus* was about the size of a fox. *Miohippus* and *Anchitherium*, from the Miocene, were about as large as a sheep. *Hipparion* and *Pliohippus*, of the Pliocene, equalled the ass in height: while the size of the Quaternary *Equus* was fully up to that of the modern horse.

The increase of speed was equally marked, and was a direct result of the gradual modification of the limbs. The latter were

Fig. 75.



a, Orohippus (Eocene); *b*, Miohippus (Miocene); *c*, Hipparion (Pliocene); *d*, Equus (Quaternary).

slowly concentrated, by the reduction of their lateral elements and enlargement of the axial one, until the force exerted by each limb came to act directly through its axis, in the line of motion. This concentration is well seen, *e. g.*, in the fore limb. There was, 1st, a change in the scapula and humerus, especially in the latter, which facilitated motion in one line only; 2d, an expansion of the radius, and reduction of the ulna, until the former alone remained entire, and effective; 3d, a shortening of all the carpal bones, and enlargement of the median ones, ensuring a firmer wrist; 4th, an increase in size of the third digit, at the expense of those on each side, until the former alone supported the limb. The latter change is clearly shown in the above diagram (Fig. 75), which represents the fore feet of four typical genera in

the equine series, taken in succession from each of the geological periods in which this group of mammals is known to have lived.

The ancient *Orohippus* had all four digits of the fore feet well developed. In *Miohippus*, of the next period, the fifth toe has disappeared, or is only represented by a rudiment, and the limb is supported by the second, third and fourth, the middle one being the largest. *Hipparion*, of the later Tertiary, still has three digits, but the third is much stouter, and the outer ones have ceased to be of use, as they do not touch the ground. In *Equus*, the last of the series, the lateral hoofs are gone, and the digits themselves are represented only by the rudimentary splint bones.* The middle, or third digit, supports the limb, and its size has increased accordingly. The corresponding changes in the posterior limb of these genera are very similar, but not so striking, as the oldest type (*Orohippus*) had but three toes behind. An earlier ancestor of the group, perhaps in the lowest Eocene, probably had four toes on this foot, and five in front. Such a predecessor is as clearly indicated by the feet of *Orohippus*, as the latter is by its Miocene relative. A still older ancestor, possibly in the Cretaceous, doubtless had five toes in each foot, the typical number in mammals. This reduction in the number of toes may, perhaps, have been due to elevation of the region inhabited, which gradually led the animals to live on higher ground, instead of the soft lowlands where a polydactyl foot would be an advantage.

The gradual elongation of the head and neck, which took place in the successive genera of this group during the Tertiary period, was a less fundamental change than that which resulted in the reduction of the limbs. The process may be said to have already began in *Orohippus*, if we compare that form with other most nearly allied mammals. The diastema, or "place for the bit," was well developed in both jaws even then, but increased materially in succeeding genera. The number of the teeth remained the same until the Pliocene, when the front lower premolar was lost, and subsequently the corresponding upper tooth ceased to be functionally developed. The next upper premolar, which in *Orohippus* was the smallest of the six posterior teeth, rapidly increased in size, and soon became, as in the horse, the largest of the series. The grinding teeth at first had very short crowns, without cement,

* The modern horse occasionally has one of the ancestral hooflets developed, usually on the fore foot.

and were inserted by distinct roots. In Pliocene species, the molars became longer, and were more or less coated with cement. The modern horse has extremely long grinders, without true roots, and covered with a thick external layer of cement. The canine teeth were very large in *Orohippus*, and in this genus, as well as those from the Middle Tertiary, appear to have been well developed in both sexes. In later forms, these teeth declined in size, especially as the changes in the limbs afforded other facilities for defence, or escape from danger. The incisors in the early forms were small, and without the characteristic "mark" of the modern horse. In the genera from the American Eocene and Miocene, the orbit was not enclosed behind by an entire bridge of bone, and this first makes its appearance in this country in Pliocene forms. The depression in front of the orbit, so characteristic of *Anchitherium* and some of the Pliocene genera, is, strange to say, not seen in *Orohippus*, or the later *Miohippus*, and is wanting, likewise, in existing horses. It is an interesting fact that the peculiarly equine features acquired by *Orohippus* are retained persistently throughout the entire series of succeeding forms. Such, *e. g.*, is the form of the anterior part of the lower jaw, and also the characteristic astragalus, with its narrow, oblique, superior ridges, and its small articular facet for the cuboid.

Such is, in brief, a general outline of the more marked changes that seem to have produced in America the highly specialized modern *Equus* from his diminutive, four-toed predecessor, the Eocene *Orohippus*. The line of descent appears to have been direct, and the remains now known supply every important intermediate form. It is, of course, impossible to say with certainty through which of the three-toed genera of the Pliocene that lived together, the succession came. It is not impossible that the later species, which appear generically identical, are the descendants of more distinct Pliocene types, as the persistent tendency in all the earlier forms was in the same direction. Considering the remarkable development of the group through the entire Tertiary period, and its existence even later, it seems very strange that none of the species should have survived, and that we are indebted for our present horse to the old world.

NOTES FROM THE JOURNAL OF A BOTANIST IN EUROPE.

BY W. S. FARLOW, M.D.

PART III. GENEVA AND THE ALPS.

After a month of wandering through Switzerland and northern Italy, I have, at length, settled in this charming city for the purpose of more systematic botanical study than one is likely to undertake in such resorts as Grindelwald and Zermatt. I arrived in Switzerland from Munich about the middle of July, and reached Grindelwald on the 20th, when the alpine vegetation was in full bloom, and I think I never saw such a display of wild flowers as was then to be found in almost all the high pastures, or Alps proper, and, still higher up, on exposed rocks just below the snow line. For the European botanist, who is only in search of rarities, Zermatt is much richer than Grindelwald. In general, Dauphiny is more favorable for the botanist than Switzerland itself, but to an American, who must, at least, see Switzerland and who wishes to get a good general idea of the alpine flora at the same time, no place seems to me better adapted than Grindelwald. The valley is easily and quickly reached and, only a few steps from the village, is the moraine of the lower glacier which, by a constant recession (according to the guides) for twenty years, has left exposed a mass of rocks on which, but more particularly along their border, may be found numerous alpine and sub-alpine plants. Amongst the most beautiful and common, are *Linaria alpina* DC. and *Epilobium Fleischeri* Hochst. which attract the eye of non-botanical travellers, and even of the guides themselves. To the left of the moraine (looking up) and along the path leading to the *mer de glace* one can without fatigue collect alpine plants to his heart's content, including even the famous Edelweiss, *Leontopodium alpinum* Cass., unless he arrives a little late in the season, in which case, every trace of it will have disappeared under the devastations of guides and tourists. For my part, I can't see the least beauty in the flower, and it was a great annoyance to have a handful thrust into my face every few minutes by some enterprising, but not over-polite, Swiss boy. It does very well, how-

ever, for the guides to wear a sprig in their hats, it gives them such a decided alpine look and, then, it is so romantic. Every one has heard about the chamois hunters who imperil their lives in gathering the Edelweiss growing about half-way up steep precipices, nobody knows how many thousand feet high, all for the sake of some beauteous maiden. At present, maidens of the above class have probably retired to the remotest valleys; at any rate, they are not met with in Grindelwald. But Edelweiss may be had without great risk of life or limb; for while crossing the Simplon I had only to step out of the diligence to pick specimens of it growing on some rocks near the road. But, to return to our path to the *mer de glace* — along the lower portion a most beautiful effect is produced by the quantities of *Phalangium ramosum* Lam. and *Astrantia major* L., growing together, the latter proving that even an umbellifer can be beautiful. Above, on the mountain, *Aconitum Napellus* and *A. lycoctonum*, with numerous Caryophyllaceæ, attract the attention of the traveller.

No one who is so fortunate as to be in Grindelwald in July, or the beginning of August, should fail to ascend the Faulhorn. After emerging from the forest, uninteresting, except from a few *Campanulæ*, to all but lichenologists, one finds in abundance the beautiful alpine rose, *Rhododendron ferrugineum* L., which the ladies are so fond of fastening in bunches to the ends of their alpenstocks; and, growing with it in abundance, but flowering a little later, the odd *Gentiana punctata* L. After passing the châlet, the really alpine flora is first seen in a meadow blue with *Gentiana Bavarica* and *G. verna* mixed with Androsace, while the most beautiful *G. acaulis* occurs farther on. Every step discloses new beauties, the fragrant *Nigritella angustifolia*, *Violæ*, *Primulæ*, *Sempervivæ*, *Saxifragæ* and composites without end, till the climax is reached at a little knoll not far from a small black looking lake, just under the snow fields, which is covered with *Soldanella minima* Hoppe. The nodding of the beautiful little purple-blue corollas, the distant tinkling of hundreds of bells from a large herd in the alp below, the bare black rocks and snow ahead, and behind the magnificent mass of the Wetterhorn, from which one hears constant avalanches, all form a picture which no one is likely to forget.

The proper time for seeing the alpine flowers is from the middle of July till the middle of August, better however in July. Those who arrive late in August, as do most of the Americans, will search

in vain, even in the richest localities, for a glimpse at the wonderful profusion and brilliancy of the mountain flora. Single specimens of many and some even rare species may then be found, but the flowers will have ceased to be a feature of the landscape. The lichenologist will find superb specimens of *Evernia divaricata* in fruit in the forest between Grindelwald and the Rosenlaui glacier.

I regret not having had time to explore the St. Gothard for lichens which are said to be interesting in that region. The rocks below the celebrated Devil's Bridge were covered with *Gyrophoræ*, mostly common species, however. The richest botanical field of Switzerland which the American is likely to visit is Zermatt, at the foot of Monte Rosa. Here, there is enough to catch the eye of the traveller, but the species for which Zermatt is particularly famed must be diligently sought, and one who expects to examine this region profitably must make up his mind to stay at least a week. Interesting plants are found on the road from Visp to Zermatt and, at least, the first half of the way, as far as St. Niklaus, had better be made on foot for that reason. The Riffelberg is interesting in the season but, by the middle of August, not very much is to be found. The *Pinus cembra* of this mountain, and the larches whose trunks are gay with *Evernia vulpina*, are certainly worth seeing.

As far as botany is concerned, Chamounix is very uninteresting, although the lichens are tolerably numerous. The Flegére is almost stupid in its monotony, and the only plant of any interest is the fern *Allosorus crispus*, abundant just before entering the forest. Attracted by the name "le Jardin," I started off early one morning expecting to return laden with treasures. The scenery was magnificent, but the so-called garden is destitute of all but common alpine plants, such as *Gentiana punctata*, *G. Bavarica*, *Linaria alpina*, etc. The excursion on the whole is fatiguing over the *mer de glace* as far as can be seen from Montanvert, then, round a corner of the *Aiguille du moine* to the Telafére moraine, then a horrid climb up the moraine relieved only by the bright flowers of *Adenostytes albifrons*, and across the Telafére glacier to the Jardin; in all, a walk of nine hours over snow, ice and moraines.

Let me now say a word about the books a traveller had better take with him to the botanical districts. I started with Koch's "Taschenbuch der Deutschen und Schweizer Flora," which I found

to answer the desired object very well, although it is somewhat antiquated. It is not in print, however, and can only be obtained at second-hand bookstores of the large cities. I had the misfortune to lose my "Taschenbuch" and had some trouble in finding a substitute at Lucerne. Let me warn all your readers against a wretched "Taschenbegleiter des Alpenclubisten" by Dr. R. T. Smiler. One might just as well try to find a plant in Bradshaw's "Railway Guide." At last, in Geneva, I found an excellent little guide called "Flore analytique de la Suisse" by P. Morthier of Neuchatel, second edition, 1872. It is compact and, if only decently bound, instead of being in paper covers like all continental books, would be as convenient as possible. The orders are arranged according to the natural, but the key on the Linnæan, system. The author, it must be remarked, has a very neat way of getting over difficulties in the larger and more complicated genera. The principal species are clearly given and, at the bottom of the page, a note like the following: Between species A and B are several hybrids known as species C, D, E, etc., of different authors. This might certainly be called eliminating difficulties.

Geneva, although long known as the residence of distinguished scientific men, is not, at present, so much frequented by Americans who wish to pursue science as the German University towns. The Academy partakes to a large degree of the nature of a German gymnasium. This is owing, partly, to the absence, until recently, of good practical laboratories which are so common in Germany, and to which that country is indebted for the large influx of foreign students. Recently, however, the new Academy buildings have been finished in a very substantial manner, and the number of laboratories, chemical, physical, anatomical, physiological, botanical, zoological, etc., is quite astonishing. It is said that a part of the large sum bequeathed to the city by the late Duke of Brunswick is to be devoted to improving the Academy and raising it to the rank of a University. I have no doubt this will soon be done, and then Geneva may attract American students, as the beauty of its situation and the opportunities for learning French are two very decided advantages.

Botany is, at present, represented here by M. Alphonse de Candolle and his son M. Casimir and Dr. Johann Müller, called Argoviensis, to distinguish him from the numerous other Müllers, distinguished in botany and zoölogy. M. Edward Boissier re-

sides near the city, and the aged M. Duby a short distance up on the lake. Besides these is a M. Thurie, professor of vegetable physiology. The laboratory of the latter has been recently fitted up. The botanical garden, although forming a very pleasant playground for children and their nurses, is hardly what one would expect from a city in which three generations of De Candolles have lived. It is whispered that the city government prefers to use it as a propagating garden for the supply of the public squares and parks.

In herbaria the city is very rich, there being, at present, three distinct large collections; the De Candolle herbarium opposite the cathedral; the collection of M. Boissier at his residence; and that of Delessert formerly in Paris. The latter is not yet arranged and will be for some time particularly inaccessible. The De Candolle herbarium is in two divisions; the first, from which the earlier volumes of the Prodromus were written, remains as a classic memorial of that work, no additions or alterations being made in it, but all purchases and exchanges are inserted in the second herbarium, which contains the materials of the later volumes.

The curator of the herbarium is Dr. Müller, whom I found on my arrival resting from the fatigue arising from his work on Brazilian Rubiaceæ, by devoting himself to his favorites the lichens. With his assistance I was enabled to study the lichen flora of Geneva. This excellent botanist and most amiable man has an extensive general knowledge of all branches of botany, and does not turn up his nose at the smaller plants as beneath his notice. In his knowledge of lichens he has few equals in Europe, although most of his time is given to the study of phænogams. The Vegetations-punkt mania does not prevail at Geneva as in Germany, where it affects many of the younger botanists to such an extent that they are quite unfitted for practical work. The Germans are constantly making the mistake that everything microscopic is important, in fact more important than anything else.

The flora of Geneva is exceedingly interesting, the city being situated at a point where a northern and southern flora unite. It was too late to study the phænerogams when I arrived, but the lichens are always in season. A short hour from the city is the Pas de l'Echelle leading to the passage between the Grand and Petit Salève. Here is the original station of a number of

species of lichens. Along the path one sees rocks and stones bearing marks of the chisel. These were made by Dr. Müller who points out the identical spot where the first *Amphiloma granulosum* was found by him, as well as other new species. Everywhere lichens abound. In the passage above, between the Grand and Petit Salève, the rocks of the two sides bear different species: to the left, the rare *Toninia Boissieri*, *Lynalissa Salivensis* and *Omphalaria pulvinata*, and to the right, many *Verrucariaceæ*. At present, more than a thousand species of lichens have been found in the vicinity of Geneva, a very large number for a local flora. In one spot a number of holes have been drilled into the rocks, and Prof. DeBary one day suggested jokingly, that Dr. Müller was going to blow up the mountain to see if he could not find some new species inside. To show how thoroughly Dr. Müller has explored this region (pointing to a ledge of rocks) he said that he began at one end one Sunday, and examined a certain tract marking the place where he left off, and returned on successive Sundays until the whole ledge was explored. The Eldorado of lichenologists is near the summit of the Grand Gorge on the Grand Salève. Between the fallen boulders at the foot of the mountain is found *Cyclamen Europæum* in abundance, and also the rare fern *Asplenium Halleri* which generally grows with *Solorina saccata*.

On the opposite side of Geneva from the Salève and farther distant are the highest summits of the Jura, the Dôle, Colombier and Reculet. Of these the Dôle is the most accessible. The ascent is made from St. Cergues about three hours distant from Nyon on the lake. The excellent road ascends gradually to St. Cergues and affords magnificent views of the lake and Mt. Blanc. It is from this route that one is best enabled to form a correct idea of the height of the latter mountain which seems to rise higher and higher, while the lower mountains, as the Salève and the Mole sink gradually until they are lost in an undulating plain. At St. Cergues the traveller finds himself in a very primitive region. The doors of the rooms at the inn are destitute of bolts or locks. There being no fire or possibility of a fire except in the kitchen I took refuge in that apartment and looked on in astonishment while the landlady made soup of bread, water and garlics. The "anything warm that I wanted" turned out to be cold Swiss sausage. All that I can forgive, but why would the

landlady stand by me while I was eating, and ask if I liked the food? Of course, I had to say it was delicious. The next day, with a gendarmes as a guide, carrying an enormous basket with a very little luncheon, I went to the summit, passing through large forests of *Abies excelsa*, and pastures full of the beautiful *Gentiana ciliata*. The rocks of the summit were covered with lichens, the most striking of which were *Biatora rupestris*, var. *calva*, *Verrucaria plumbea*, *V. Dufourii*, *Blastenia Agardhiana*, *B. nubigena*, *Caloplaca chalybæa* and *Biatora Jurana*. Having disposed of our luncheon, I soon managed to fill the basket, my box, and all my pockets to overflowing, to say nothing of two or three leaves of *Cirsium ferox* covered with a *Puccinia*, and several large agarics which I carried in one hand. The gendarmes did not seem to mind the *Cladoniæ* and *Parmeliæ* much: but I thought his countenance fell as he saw the *Verrucariæ* and other mineralogical plants going into the basket which I kindly allowed him to carry. Returning to Nyon in the omnibus I managed to incommode my neighbors by the specimens in my coat pockets. In my lap was a heap of *Cladoniæ* and *Peltigeræ*, and a worthy Switzer opposite got his feet entangled in the strap of my botanical box, where were my choicest specimens, and I soon saw it moving towards the door bottom upwards with the cover open. But every one was restored to good nature by a young lady, just from Paris, who distributed a package of candy amongst the company.

An interesting locality for lichens is along the Arve above Geneva; but, at the time of my visit, the stones on which they grow were under water. Only in spring can one collect there with advantage. During his excursions in the higher Alps, M. Casimir De Candolle has made some interesting discoveries with regard to the height at which lichens grow. He found on the summit of Monte Rosa (15,217 ft. high) *Amphiloma murorum*. The upper part of the Schreckhorn (13,386 ft. high) is covered with lichens; so far as is known, however, only common species.

REVIEWS AND BOOK NOTICES.

SURVEYS WEST OF THE 100TH MERIDIAN.—We have before us Lt. Wheeler's preliminary report of progress of the geographical and geological surveys, and explorations west of the 100th meridian in Nevada, Utah, Colorado, New Mexico and Arizona. The fourth season of field work was brought to a close in December last, when the parties returned to Washington to elaborate results. These surveys have been made to perfect and supplement each other in such a way that a vast extent of country has been covered in, from central California over a great part of Nevada, as far east as eastern Utah and south including Arizona. The initial work of surveys consists in the accurate mapping out of the public domain lying to the westward of the 100th meridian. To accomplish this, a number of skilled topographers and astronomers have been employed, whose successful efforts can hardly be overestimated in these particular lines. As collateral branches of the work, geology mineralogy, chemistry, botany, ethnology and zoology, all have received due share of attention and large collections have been made, amounting to many thousands of specimens. In addition to these scientific subjects, the questions more especially bearing on political economy have been carefully discussed; such as methods of irrigation, mining, etc., the establishment of military posts, etc. Numerous photographs were taken representing the ancient as well as modern dwellings of the Indians, the geological formations, mountains, etc. A vast amount of manuscript is in hand ready for publication should Congress make the necessary and highly proper appropriations. Probably not less than fifty new species of insects, fish, etc., will be figured in the reports, which will consist of seven quarto volumes besides an atlas of maps, which is already near completion. From the maps we have seen, we judge that they are probably the best of the country ever made. This year's work will consist of labors in the mining district known as *Snab* in Colorado. The *personnel* of the party is nearly the same as heretofore, consisting of the following accomplished officers; among the names will be recognized several well known to naturalists:—Lt. G. M. Wheeler, Corps of Engineers in charge; Lt. W. M. Marshall, Corps of Engineers Astronomical; Lt. R. H.

Hogie, Corps of Engineers Meteorological; Dr. H. S. Yarrow, U.S.A., Surgeon and Naturalist; Dr. J. T. Rothrock, U.S.A., Surgeon and Botanist; Dr. Oscar Loew, Chemist and Mineralogist; H. W. Henshaw, Assistant Naturalist and Ornithologist; besides a corps of trained collectors.

The area gone over in 1873 was no less than 76,000 square miles, and Lt. Wheeler's work has probably not been surpassed for general accuracy and minuteness of detail. Dr. Yarrow's name, as that of the officer in charge of Natural History division of the work, is sufficient guarantee of the highly creditable manner in which that branch of investigation is conducted. His results, to many of which we have already enjoyed access, are of great interest and importance. It is to be earnestly hoped that this great and most important work may not be restricted for want of the funds needed for its completely successful prosecution.—ELLIOTT COUES.

CHECK LIST OF COLEOPTERA.*—A new and revised list of our beetles has long been needed, as a convenience in arranging our cabinets and facilitating exchanges. Its publication has also been necessitated by the numerous changes which have been made in synonymy, mostly based on comparisons made by Dr. LeConte in Europe, and others from examinations made by the author. Some important changes have been made in the arrangement of the families, the Coccinellidæ, Erotylidæ and Endomychidæ being placed in the Clavicorn series by Mr. Crotch, an important measure sanctioned by Drs. LeConte and Horn, while the weevils are placed at the end of the series in accordance with the views of Dr. LeConte.

DICTIONARY OF ELEVATIONS OF THE UNITED STATES.†—Though of special value to physicians, this book will be useful to those interested in the geographical distribution of plants and animals, as the elevations of many points, particularly in the Rocky Mountains, are given in a compact form. The Dictionary contains in

*Check List of the Coleoptera of America north of Mexico. By G. R. Crotch. Salem, Mass., Naturalists' Agency, 1874. 8vo, pp. 136. $1.00.

†Dictionary of Elevations and Climatic Register of the United States; containing, in addition to elevations, the latitude, mean annual temperature, and the total annual rainfall of many localities; with a brief introduction on the orographic and other physical peculiarities of North America. By J. M. Toner, M. D. New York. Van Nostrand, 1874. 8vo, pp. 93. Price $3.00 paper; $3.75 cloth.

addition to elevations, the latitude and mean annual temperature of many localities. We notice some inaccuracies and omissions in comparing it with "Gannett's List of Elevations" published by Hayden's Survey, those relating to the heights of prominent mountains being inexcusable. These, with typographical and other errors, show that it should be consulted with some caution.

Flora of Colorado.*—The inhabitants of the far west and eastern tourists will have reason to thank Dr. Hayden for the useful series of practical manuals of the natural history of the Rocky Mountains he is so energetically pushing on to completion. This synopsis, the first of the series, is very opportune, as it places in the hands of the tourist or botanist a ready means of identifying the plants of a region so rich in interest as Colorado. We only regret that the preliminary essay on the geographical distribution of the Rocky Mountain flora could not have appeared in the same volume.

The plan followed in the synopsis is that of Mr. Watson in his catalogue contained in the fifth volume of "King's Report on the Geology, etc., of the Fortieth Parallel." Descriptions are given of all the plants not mentioned in "Gray's Manual," "Chapman's Flora" and other floras of the eastern states.

The mosses and Hepaticæ have been elaborated by Mr. L. Lesquereux, the lichens by Mr. H. Willey, and the fungi by Mr. Peck, while the name of the author of the larger portion on Phanerogams is a sufficient guarantee of the quality of the work.

BOTANY.

Abnormal form of Allosorus acrostichoides.—On a visit to Isle Royale, Michigan (Lake Superior), in August, 1873, I collected some nice specimens of that peculiar fern *Allosorus acrostichoides* Sprengel (*Cryptogramma acrostichoides* R. Br.). One large handsome plant I succeeded in transporting to Detroit, where it at present flourishes on a rockwork made for the purpose. It affords an instance of a curious abnormality which, I believe, has not hitherto been noticed in this fern. I refer to its producing fronds

*Synopsis of the Flora of Colorado. By Thomas C. Porter and John M. Coulter. Department of the Interior U. S. Geological and Geographical Survey of the Territories. F. V. Hayden, U. S. Geologist, in charge. Miscellaneous Publication, No. 4. Washington, 1874. 8vo, pp. 180.

in which the upper part is fertile, having the usual very narrow linear divisions, while the lower part, barren, has all the characteristics of the sterile frond with its "obovate decurrent and crenately toothed or incised segments." The abnormal frond is also quite as tall as the fertile fronds, which in this fern, it is well known, have always much taller stipes than the sterile fronds, lifting them high above the latter.

I was much gratified to behold this dainty graceful fern growing in its native haunts — its isolated home. It was now in full perfection, which was not the case at the time of my first visit to the island, in May. I observed that it generally grew in clefts or on shelves of the outcropping ridges of metamorphosed sandstone, partially shaded by trees, and always facing the south. It was invariably surrounded with a mass of *débris* largely formed of the decayed fronds of numerous previous generations of the fern, while the straw-like stipes of many years remained erect and dry encircling the plant below, and no doubt affording it valuable protection.— Henry Gillman, *Detroit, Michigan.*

Rumex patientia L. — This rumex is not mentioned in Wood's Botany, and the brief reference to it in the last edition of Gray's Manual in connection with Amherst, Mass., suggests that it is comparatively rare. It may therefore be interesting to botanists, to know that it is not uncommon in Amherst, and at least three of the neighboring towns, growing by the roadside or near dwellings. And when the writer was at Highgate Springs in northwestern Vermont during the past season, it was everywhere as abundant and apparently as much at home as any of our introduced rumices. — H. G. J.

The Northernmost Flowering Plants.—Dr. Bessels, of Hall's Arctic expedition, collected according to a note in "Nature" by Dr. J. D. Hooker, four plants from the east side of Smith's Sound in latitude 82° N. They are *Draba alpina* L., *Cerastium alpinum* L., *Taraxacum dens-leonis* Def. var. and *Poa flexuosa* Wahl. This is the most northern locality where any phanerogamous vegetation has been found.

The Small-flowered Parnassia in Michigan.— In the summer of 1866, I made the interesting discovery of the small-flowered grass of Parnassus (*Parnassia parviflora* DC.), at White-fish Bay, Wisconsin, on the northwest shore of Lake Michigan. The

elegant little plants grew in patches of moss, in clefts of the rock, within reach of the spray from the lake.

As I was the first to discover this flower on Lake Michigan (in Wisconsin), so now, I believe, I am the first to find it in the state of Michigan, and thus have the pleasure of adding to its flora this somewhat rare plant. I found it to-day (August 1, 1873), growing rather abundantly on Grand Island, Michigan, along the high cliffs of red Potsdam sandstone overhanging Lake Superior. At this date some of the plants are in full flower, others have gone to seed, while a number have flower-buds still unexpanded.

I wish to call attention to the number of the sterile filaments in each set — so specific a distinction in this genus. Gray gives the number in *P. parviflora* as "about five in each set," which corresponds, I think, with other descriptions. In a large number of specimens which I have to-day carefully examined, I find the sterile filaments from six to nine, and occasionally eleven in each set; but oftenest they are seven. This about agrees with my Lake Michigan plant. The flower is from five-eighths to three-fourths of an inch broad; and the petals are decidedly (generally one-fourth to one-third) longer than the calyx. The ovate or rather oblong leaves are somewhat heart-shaped at the base.

These Lake Superior plants, growing mostly on the soft and disintegrated sandstone, are of more luxuriant appearance than my specimens from Lake Michigan, which grew on limestone rock. I observed that matlike tufts of the plant, which had fallen from the beetling cliff, frequently took root and flourished on the beach below; though, doubtless, they are in such cases often swept away by the fierce waves of Lake Superior.

It seems to me that the Parnassias would make interesting garden plants, and prove easy of cultivation. Their cup-like flowers, of a delicate white finely veined with green, could not fail to be considered ornamental; while the lengthy period of blossoming would be an additional recommendation. — Henry Gillman, *Detroit, Michigan.*

The Fresh water Algæ of North America.—Students of our fresh water algæ will find in the beautiful and interesting work of Dr. H. C. Wood, Jr., "A Contribution to the History of the Fresh Water Algæ of North America," a ready means of identifying their specimens. It is a large quarto volume, with many colored

plates, and is taken from the Smithsonian Contributions to Knowledge.

APLECTRUM HYEMALE AGAIN.—Of the thirty plants of *Aplectrum hyemale* Nutt., transferred to my garden from the woods north of Detroit, on the 20th of April, 1873, mention of which has already been made in the NATURALIST, but two sent up flower scapes and of those but one came to perfection. The petals of this expanded on the 5th of June. The other scape proved abortive, the raceme not appearing from the sheath.

At the date of October 1st most of the new leaves of my plants were from one inch to three inches above ground, while some were only just protruding from the earth. The plants seem to be quite healthy.

Numerous communications, received from various places since the printing of my note, are mostly confirmatory of the opinion I had arrived at as to the rarity of the blossoming.

As a generally accepted opinion is that this plant is not found in Massachusetts, I would here say that I have lately been informed on reliable authority that there is but one known station for it in that state, viz., Amherst, where for two or three seasons it has been collected in flower.

I omitted mentioning in my former note that on June 30, 1870, I collected in our woods a single withered scape with pods, of the previous season, showing that the plant had flowered there in 1869.—HENRY GILLMAN, *Detroit, Michigan.*

DEVELOPMENT OF FERNS WITHOUT FERTILIZATION.—At a late meeting of the American Academy of Arts and Sciences, Prof. Gray communicated a paper by his former pupil, Dr. W. G. Farlow, now in Germany, on the development of ferns from the prothallium irrespective of fertilization, by a sort of parthenogenesis. The growth observed took place, not from an archegonium, but from some other part of the prothallium.

LOBELIA SYPHILITICÆ VAR. ALBA.—In 1868 I found near Princeton, N. J., a single plant of *Lobelia syphilitica* v. *alba*, which must be very rare in this country. It was found among many other plants bearing blue flowers—though in this case they were *perfectly* white—and continued to bear white flowers for three years as did also the seedlings from this plant. After this time I lost sight of

the plants. Paxton (Bot. Dict.) instances the var. alba, but American authors do not look upon it as a permanent variety.—J. S. Hough.

ZOOLOGY.

Olive-sided Flycatcher.—In the December number of the Naturalist Mr. C. Hart Merriam, in remarking on *Contopus borealis*, states, that he obtained a fine specimen at Easthampton, Massachusetts, and asks if this species has ever been taken in Massachusetts before.

During the past three or four years I have observed each year several specimens of this beautiful flycatcher in the vicinity of Cambridge, Mass., and although I consider this a rare bird with us, I am inclined to think a few breed within the limits of the state every year. I have always observed it in May or June, though specimens have been captured here in the fall.

With us it is a very wary and shy species when it first arrives from the south, frequenting the topmost branches of tall trees, and its mild, clear notes can be heard at a long distance, but at the Umbagog Lakes, in Maine, where it breeds in numbers, it does not show nearly so much shyness as it exhibits during its northern migrations through Massachusetts. I have taken several specimens there in the course of a few hours.

On the 23d of June, 1873, I had an unusual opportunity of observing a pair of *Contopus borealis* in Belmont, Mass. For several days previous I had heard one of the flycatchers uttering its peculiar call from a hillside which was sparsely covered with firs.

On the above date, as I was passing that locality, I again heard the notes of this bird in nearly the same place, and thinking it must be breeding I approached in the direction of the sound, and soon saw the flycatcher in question sitting, in its erect posture, on the top of a small fir tree. I was surprised at the near approach it allowed me, as I was within a few yards of the tree before the bird took flight, though but for a short distance, however, as it alighted on the dead branch of a maple a few yards off, and was then joined by its mate. I then secreted myself in a clump of barberry bushes where I remained for some time watching them.

From the uneasiness the birds exhibited, I was convinced they had a nest in the immediate vicinity, though the locality was not particularly adapted for breeding, but although I searched dili-

gently I was unable to find the nest. I am aware that there have been several nests found in eastern Massachusetts, though this must certainly be its most southern breeding range.

I have thought the species must leave us on their southern migration by the first of September, though I saw one specimen at Moosehead Lake, Maine, as late as the 1st of Oct., 1873, at which period the weather was quite cold, water freezing round our camp most every night.—RUTHVEN DEANE, *Cambridge, Mass.*

THE OLIVE-SIDED FLYCATCHER.—At the close of an article on *Contopus borealis*, which appeared in the December number of the NATURALIST (page 750), I made the inquiry "Has this species ever been obtained in Massachusetts before?" Since then I have ascertained that specimens of it have been collected in eastern Massachusetts by Mr. C. J. Maynard, Wm. Brewster, Esq. and others, and that it occasionally breeds within the state.

In addition to the note previously described, Mr. Nuttall said: "The female had a whistling, oft-repeated, whining call of *'pŭ 'pŭ*, then varied to *'pŭ 'pĭp*, and *'pĭp 'pŭ*, also at times *'pĭp 'pĭp 'pŭ*, *'pĭp 'pĭp 'pĭp*, *'pŭ 'pŭ 'pĭp*, or *'tŭ 'tŭ 'tŭ*, and *'tŭ 'tŭ*. The male, besides this note, had, at long intervals, a call of *seh 'phèbēē* or *'h 'phebéă*." It is such a difficult undertaking to represent accurately the note of a bird by means of letters, that no two persons describe that of the same species by the same characters, although when pronounced, the syllables generally give the same sound. Thus Mr. Nuttall's call of *'h 'phebéă* is undoubtedly the same as that described by myself as *O whéŏ*. His imitation of the note of the female bird is most excellent: I have heard it many times and omitted giving it only because I neglected to write it down while in the field, and it will never do to trust to memory for such matters.—C. HART MERRIAM.

MICROSCOPY.

ON THE STRUCTURE OF DIATOMS.—It is hoped that the publication of the following memoranda will serve the double purpose of elucidating the structure of the tests, and at the same time demonstrating the utility of microscopical objectives of exceptionally high powers. The uncertainty of the footing in this unstable and contested ground will necessitate many errors, and may serve as

an excuse for them. So many competent microscopists have written upon this subject that the writer would fain be silent were it not for a firm belief in the superiority of the instrument he used, for this kind of investigation. In fact this excellent glass gives advanced work on almost every test tried, and fully justifies the confidence reposed in it. The observations recorded below, unless where otherwise stated, were made with a Tolles' $\frac{1}{50}$ immersion objective of 165° angle of aperture, and generally a Tolles' two inch eye-piece, giving an amplification of 2500 diameters.

Eupodiscus Argus.—My attention was especially called to this shell by having noticed the wide difference between the views of Mr. Henry J. Slack, Mr. Samuel Wells and Mr. Charles Stodder. My observations are corroborative of the idea of two plates as asserted by Messrs. Stodder and Wells. Using a $\frac{2}{3}$ objective with power of 340 times obtained by high eye-piece and extending draw-tube, and using a Lieberkühn, the outside or coarser markings on specimens mounted convex side uppermost are white with white cloud illumination. An erased space on one shell and the holes or depressions through which Slack's four large "spherules" are seen are now black. They, then, are not covered by the external "crust."

The slide was then turned over and the inside of the same specimen examined by the same method, and on the more favorable portions of it the finer net-work of the *inner plate* is also seen in white, the "spherules" being perfectly black. By this reflected light the "four spherules" are plainly seen to be dark openings in the white plate and the net-work is clearly traced across the areolæ in the outside plate. The diatom looks like a piece of coarse white netting laid over a finer piece.

Under the Tolles' $\frac{1}{50}$ and with transmitted light, whether central or oblique, it matters not, all portions of the surface of both the upper and the lower plates are found to be covered with, or composed of, a *still finer net-work* with irregular oval meshes like the two coarser ones.

The place in the shell above referred to, where the layers are erased, denuding an interior structureless "vail," gives an opportunity to observe the edges of the fractured layers. The broken edges of both plates bordering on the erasure show the jagging of this finest net structure. The arrangement of the finest areolæ is

more regular near the margin of the diatom or appears so by reason of the simpler character of the structure in that part. They are easily seen with the $\frac{1}{50}$ on any part of every specimen studied, but are unusually distinct between the "four spherules" on the inner plate looking through the largest openings in the outer plate; or may be rendered still more distinct on shells with the concave side up. They are more difficult to be seen on the outside crust with the high powers used because of its greater opacity. Deductions from focal changes with reference to the various markings lying in different focal planes corroborate the conclusions above expressed.

The disks examined are on Möller's Probe-Platte and on a slide prepared by Mr. Wells.

Hyalodiscus subtilis Bailey.—On this beautiful little shell the "engine rulings" are readily seen with almost any illumination, and the inevitable concomitant of intersecting lines, whether real or illusory beading are displayed. When we use monochromatic light the whole scene is changed. The hyaline portion of the disk is instantly resolved into perfectly well defined hexagons, radiating from the central nucleus. The central part because of its greater depth and complexity is only resolved into irregularly shaped spaces of a more or less hexagonal form. Every one of the five beads usually seen represents the centre of an hexagonal plane exactly as in *Pleurosigma angulatum*.

The hexagons are well defined with a power of 7,000 diameters. They may also be seen with lamp or daylight.

Triceratium favus.—The two sets of markings on this fascinating object certainly lie in different focal planes (see Carpenter, "The Microscope," 4th ed., p. 282 and note) and probably "belong to two distinct layers." The coarse hexagonal ridges are found to project from the outer or convex surface, and the inner plate bears the minute markings. This is proved by the fact that the fine markings show decidedly the plainest on valves that are mounted with the interior surface uppermost.

Under this superior objective the finer markings like the larger are distinctly faveolate. Their hexagonal structure is easily seen even with lamp illumination. When examining comparatively thick shells, possessing a complex structure, like the one in question, the necessity for avoiding errors caused by too intense or by excessively oblique light becomes at once apparent. The unequal

refraction of the light in passing through the external siliceous layer produces a distorted image upon and of the interior surface. In this manner distorted small hexagons may be seen along the lines of the larger net-work by a lens incapable of clearly displaying the minute hexagonal markings above described.

The best results are obtained on the *T. favus* with a moderate light nearly central.

Surirella gemma.— This beautiful form has been subjected to all the different conditions of illumination in my possession. Like other relatively thick shells the appearances presented by the markings vary greatly with the changing conditions of observation. No trouble is experienced in bringing out the longitudinal striæ, nor in making the little beauty *seem* to "wear beads." At times the beads give place to rectangles, and again after careful manipulation to sharply defined elongated hexagons ("The Microscope," Carpenter, page 182). Hartnack's hexagons as figured are too much elongated; although sometimes such an appearance is presented when the illuminating pencil is at right angles with the median line, the transverse lines being less distinctly perceptible. When the light is so arranged as to show every side with equal perfection the form of the markings is nearer that of regular hexagons.

The Amici prism is found to work excellently on the *Surirella*, and when it is used with the $\frac{1}{50}$ objective and the blue cell the slightly elongated hexagons are easily exhibited on an average frustule.

Aulacodiscus Kittonii.— This splendid disk is traced with easy angular figures evidently elevations and the spaces between the lines are undoubtedly depressions. Some of the markings are circular, others square, some pentagonal, some hexagonal and others heptagonal. Broken specimens of *Brightwellia Johnsonii* with like surface markings show the line of fracture running through the areolæ.

Navicula rhomboides.— Individual frustules of this species vary considerably in degree of difficulty of resolution. Some of the smallest valves when mounted in balsam tax the powers of excellent instruments. The writer has found all specimens whether mounted dry or in balsam to yield readily transverse striæ with oblique illumination direct from the lamp. Under the same conditions an average valve exhibits well defined longitudinal striæ.

With the ammoni-sulphate cell it is instantly and clearly shown covered in every part with squares, like *Pleurosigma Balticum*.

Navicula crassinervis.—The specimens of this variety, in my possession, are more difficult than *Frustulia Saxonica* and even rival *A. pellucida* under lamp illumination, but any clean frustule is satisfactorily resolved.

Using monochromatic light with plain mirror and Wenham's paraboloid, *longitudinal* lines are discovered. After careful manipulation both sets of lines are seen at the same time, and an appearance of beading results.

Navicula cuspidata.—Both sets of lines are easy, but the longitudinal are much closer together than the transverse. Consequently the light interlinear spaces are elongated and no semblance of beading is to be seen. In diatoms where the intersecting striæ are of nearly equal fineness the little square spaces, when not well defined, seem circular, and if the illumination by transmitted light is intense they present a raised appearance due to refraction.

Mr. Charles Stodder called my attention to this diatom with the view of ascertaining with the $\frac{1}{50}$ whether or not the two sets of lines lie in different focal planes. My observations many times repeated have convinced me that they are never both in focus at the same time, and further that the longitudinal lines are on the external surface and the transverse on the internal plate. If there are not two plates the lines may be on opposite surfaces of the same plate.

White cloud illumination is found to be much better than other and more brilliant light for demonstrating these slight differences in focal distances. Many errors of interpretation are avoided by using an approximately central pencil when the instrument used is capable of elucidating all the details of structure without greater obliquity.

Frustulia Saxonica.—In addition to my observation of longitudinal lines upon this test and resolution into dots (NATURALIST, July 1873, page 443) it may be worth noting that even with lamp illumination the $\frac{1}{50}$ has displayed the transverse much clearer than they appear in Dr. Woodward's photo-print. (Lens, vol. i, p. 197.) With oblique light direct from a small German student's lamp, without mirror, prism or condenser of any kind, a person entirely unaccustomed to the microscope could distinctly see them with

Beck No. 3 eye-piece, power 7,000 times. With the ammoni-sulphate of copper cell the longitudinal lines and dots are displayed with ease.

This is one of the most difficult test diatoms thus far studied, ranking but little easier than *A. pellucida*, *N. crassinervis* and *Nitzschia curvula*.

Amphipleura pellucida.—Many times the writer has been able to confirm the observations of longitudinal lines on this most difficult test shell, but never has succeeded in seeing the dots except with the blue cell and Wenham's paraboloid, and only then under favorable circumstances. (See I. E. Smith, in "The Lens," April, 1873, page 115. See also the NATURALIST, May, 1873, page 316.) When resolution is effected, the dots are exceedingly minute and uniform in size, showing as mere points of light when magnified 2500 times. On one occasion the writer has seen fine dark lines crossing between the transverse striæ like the steps of a ladder, the dots or spaces plainly longest in direction parallel with the median line, proving the longitudinal to be finer than the transverse lines.

One obstacle in the way of resolution of the longitudinal striæ is the presence of diffraction lines. The valves being so narrow increases this difficulty. Only after much time is wasted, and after many discouraging failures, will the patient observer receive the reward of success.

Nitzschia curvula Sm.—The unusual number of spurious appearances in this object leads me to suspect that it possesses a complicated structure as yet beyond the reach of the instrument. The extreme fineness of the longitudinal lines as compared with the transverse reminds one of the *Navicula cuspidata*, and as is the case with the coarser shell, no efforts avail to develop a semblance of beading.

Striatella unipunctata.—Two sets of fine lines, and as the direction of the light is changed, may be made to exhibit either beads or squares. In point of value as a test will be found to approach *Surirella gemma*.

Grammatophora.—Of this genus the writer has examined the *G. marina*, *G. subtilissima* and *G. serpentina;* all of which are resolved into hexagons. Broken specimens of *G. marina* show the line of fracture running through the hexagonal planes and leaving points of the net-work projecting. The markings continue com-

pletely illustrated as the stage is resolved, in whatever direction the beam of light may fall.

Stauroneis.— Some of the larger varieties of *S. phœnicenteron* are covered with hexagonal areolæ easily exhibited with central daylight. The projecting points of the fractured partitions between the hexagons may be observed.

Pleurosigma angulatum.—Hexagons. The line of fracture generally running around them, but quite often through them.

Pleurosigma Balticum.—A drop of water slowly advancing by capillary attraction shows this shell to be covered with squares, and proves that both sets of lines forming the boundaries of the squares are on the same surface of the valve; and the appearance presented by an air bubble on the other side proves that surface to be smooth.

Pleurosigma formosum.—Near the ends of the frustule it is easy under certain adjustments of the light to make it appear like a checker-board with alternate bright red and green squares. Double rows of green and red beads alternating may be seen on this as well as on other species of the same genus. (Dr. Pigott in M. M. Journal.) When we resort to central light from a white cloud, and thus lessen the liabilities to err caused by refraction, diffraction, decomposition of light, and oblique projection of shadows, the conclusion is arrived at that these various appearances are caused by two sets of intersecting diagonal ridges, the finer ridges running up and down over and between the coarser, and subject to considerable variation even on the same frustule. This theory would also account for the "beads"(?) being of different colors, and the same "beads" changing color when the focus is changed. We see in many of the mollusks shell-markings of a similar character.

Concluding remarks.—It would seem that the perfect box-like form of the shells of the Diatomaceæ and their elaborate ornamentation would exclude the idea of a blind process of chemical crystallization. Analogy should teach that they are secreted for a protective covering for the tender animal-like plant, as among higher forms. If this is true the surface markings ought to be so distributed as to give additional strength to the shell without greatly adding to its weight. It would also be expected that some of the larger shells would be perforated with holes. This idea, of course, would have to admit into the discussion consid-

erations of habits of growth, and environments. Those contained in gelatinous envelopes should be less developed in strength of shell and bracing. Those growing on algæ and in exposed localities should be strong to resist fracture. On those moving free the bracing would be in proportion to the weakness of the shell; larger shells being relatively more liable to be broken. Here as elsewhere nature without waste of material combines utility with beauty.—G. W. Morehouse.

Unmounted Objects.—At the request of a number of microscopists, Mr. Jno. H. Martin, of the Maidstone Micro-assay Laboratory, has decided to establish an agency in this country for the distribution of his well-known unmounted objects. Persons desiring to prepare their own objects can thus obtain a large variety of interesting materials at a very small cost. A stock of objects will be kept for immediate distribution, and articles that may be out of stock furnished as soon as they can be obtained from abroad. Lists and objects can be obtained by addressing, by post, C. A. Baldwin, *Troy, N. Y.*

NOTES.

A rare opportunity is offered botanists or scientific institutions of purchasing the cryptogamic herbarium of Dr. Duby (author of Botanicon Gallicum, etc.), containing the cellular cryptogams of all families except the mosses.

This collection contains first, in eighty-five packages, the herbarium of Dr. Wallroth, and includes all the species discovered by this savant and published in his "Cryptogamia Germanica," also that of Nees von Esenbeck, containing the cryptogamic species of the different families (except the lichens and Hepaticæ, which will be mentioned farther on), including a large number of fungi (among others almost all the species of Schweinitz), algæ, etc., etc. Besides these are eighty large packages containing the fungi either gathered or received by himself. Among the number are found the Hypoxyla in perfect order, enriched by authentic specimens from Fries, Montague, Fückel, Berkeley, Currey and Bischoff, perfectly named by them. In these packages are found, among other things, the Lycoperdinei, Hysteria, Uredines, Mucedines, etc., described in his "Botanicon," or other publications. Of exotic fungi the herbarium contains the species

of Carolina, published by Mr. Curtis; those of Java, collected by Mr. Zollinger, at Junghuha; those of Bahia, by Mr. Blanchet; those of Mexico, Guadaloupe, etc., etc., and a large number that have not yet been published.

As to the lichens, there are thirty-five or forty enormous packages classified by genera, in which are contained not only all those which have served for his "Botanicon Gallicum" but those of Nees v. Esenbeck, Flowtow and others; besides large invoices of exotic and European lichens from Nylander, Körber, Zollinger and others. The Hepaticæ of Nees on which the genera and species of the Hepaticology of this savant have been established, not perfectly in order, are contained in twenty-six packages, classified and labelled, and one package not classified. Lastly the algæ, studied with the greatest care, for his "Botanicon" and subsequent works, either by himself or Mr. Cronan of Brest, enriched with a large number of drawings, composing thirty-five to sixty packages, in which are comprised the algæ of Australia, Ceylon, the Pacific, United States (by Harvey); other specimens from various countries sent by various savants; the microscopic species of Brebisson and other micrographers. To all this must be added twenty-four cartons from M. Lamy de Perignam, containing many different cryptogams, studied and named by M. Montague, de Brebisson, etc.

All these treasures which he has been accumulating for fifty years, and prepared for special work of his own, but which the study of bryology has caused him to abandon, he will sell for five thousand francs.

As to the *mosses* the collection is still larger, but he will only sell it on condition that it shall remain in his hands during his life.

We hope the time is coming when rare scientific treasures like these will be presented either to the Cambridge, or some other accessible herbarium in the United States, by generous persons of means.

We reprint, from the "N. Y. Tribune," a portion of the report by Prof. E. Weiss of Vienna, who visited this country in 1872 for the purpose of acquainting himself with the condition of practical astronomy in the United States. The extract well represents some of the causes that retard original investigation in the Unite

States, and applies as well to biology as to astronomy. We look with a sort of dismay upon the future of biological science in America, so few are the earnest, self-sacrificing students who are devoting themselves to histology, embryology and experimental biology. When the fortunate moment arrives, that our flora and fauna are worked up, we hope for what the French would call *serious* work. Meantime the appeals now before the public, in behalf of the Anderson School of Natural History and the Zoological Museum at Cambridge, we trust will produce good results.

"On the other hand, of much greater importance is it that, in general, almost all scientific institutions in America feel the want of workers of every kind, and, in many cases, this want arises not so much from financial as from social relations. For the number of men who devote themselves to the service of science in America is very small, not only because the pursuits in other paths are far more profitable, but especially because the efforts of every young man are concentrated in the endeavor to earn his own livelihood as soon as possible. This latter trait of character, which most frequently hinders the pursuit of year-long earnest studies, is certainly the fundamental reason why scientific growth does not correspond to the necessities. This is the case, notwithstanding the fact that Americans are in no way disinclined towards the sciences, but, on the contrary, very highly esteem both them and the men that cultivate them, as is shown by the above-mentioned numerous gifts of private individuals for the improvement of the existing, and the establishment of new schools and scientific institutes. Furthermore, most institutions suffer from an almost constant deficiency of persons to execute the subordinate drudgery; and that, again, because of a national peculiarity. For an American would rather subject himself to the severest bodily labor for days' wages, than to enter anywhere as a servant for a long period; since, in the latter case, he must obey the orders of his master, and this he views as a deprivation of his individual freedom."

Max Schultze, the distinguished German anatomist and histologist, is dead. He was the editor of the well known "Archiv für Microscopiche Anatomie," devoted largely to the anatomy of the tissues and to the infusoria. He wrote also on the embryology and anatomy of the worms, of echinoderms and hydroid medusæ, and on the foraminifera. He was born in 1825, and died, in the prime of life, at Bonn, having just had completed for his use, as is said, the amplest and most elegantly constructed laboratory in Europe.

THE "Miscellaneous Publications" of the U. S. Geological Survey of the Territories are as follows. No. 1. List of Elevations west of the Mississippi, by H. Gannet. 2. (Unpublished). 3. Ornithology of the Territories, by Dr. Elliott Coues (to be issued in May). 4. Synopsis of the Flora of Colorado, by Porter and Coulter. 5. Descriptive Catalogue of Photographs of the survey, for the years 1869 to 1873, inclusive.

THE Boston Society of Natural History is to republish Hentz's papers on North American Spiders, to be edited by Mr. E. Burgess, with notes and two new plates by Mr. J. H. Emerton, as No. 2 of the "Occasional Papers." The work will contain about one hundred pages, and have nineteen plates, and the price will be $3.00 or $3.50.

IN the April number of the NATURALIST I find my name appears as the botanist of the Wheeler expedition of 1873, to the exclusion of my good friend Prof. John Wolf. This has been by accidental omission, I am sure, on the part of the writer of the article in question. I did have a certain connection with the botanical collection, but the bulk of the work done in that department was by Prof. Wolf, whose conscientious labor cannot be too highly commended.—J. T. ROTHROCK.

THE friends of the late Professor Agassiz, the friends of education, propose to raise a memorial to him, by placing upon a strong and enduring basis the work to which he devoted his life, the Museum of Comparative Zoölogy, which is at once a collection of natural objects, rivalling the most celebrated collections of the Old World, and a school open to all the teachers of the land.

It is proposed that the teachers and pupils of the whole country take part in this memorial, and that on the birthday of Agassiz, the 28th day of May, 1874, they shall each contribute something, however small, to the Teachers' and Pupils' Memorial Fund, in honor of Louis Agassiz; the fund to be kept separate, and the income to be applied to the expenses of the Museum.

All communications and remittances for the "Teachers' and Pupils' Fund" of the "Agassiz Memorial," may be sent to the Treasurer, James M. Barnard, Room 4, No. 13 Exchange Street, Boston.

Will not every subscriber to the NATURALIST contribute his or her mite to this great object?

THE Anderson School of Natural History will open July 7 and close August 29. We learn that over ninety applications have been made above the number which can be accommodated. This in itself is an appeal to the people to sustain the school. The funds of the school are nearly exhausted in erecting the buildings and preparing the necessary outfit. The Director of the school, Mr. Alexander Agassiz, now asks the coöperation of all interested in education in obtaining from the Legislatures of their respective states, or from other means at the disposal of State Boards of Education, a moderate appropriation say of $5,000, or an annual grant of $350, as a contribution towards the permanent support of the Anderson School. Every such share would entitle each state participating to the admission of two teachers annually as students at Penikese.

The following gentlemen will have charge of instruction in their respective departments:—Prof. B. G. Wilder (Vertebrates), F. W. Putnam (Fishes), A. S. Packard (Articulates), Profs. E. S. Morse and Hamlin (Mollusks), E. Bicknell (Microscopy), while lectures will be delivered by Mr. A. Agassiz on Radiates and Embryology, Prof. A. M. Meyer, on Physiological Physics and Mr. Theodore Lyman on Pisciculture. The laboratories will be in charge of Mr. Garman. Dr. Packard and Mr. Garman will take charge of the dredging expeditions.

BOOKS RECEIVED.

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Einundzwanzigster Bericht des Naturhistorischen Vereins in Augsburg. 8vo, pp. 138. Augsburg, 1871.

Bulletin Mensuel de la Societe de l'Acclimatation. 8vo, vol. 10, Nos. 10 and 11, 1873. Paris.

Proceedings of the Imperial Botanical Garden of St. Petersburg. 8vo, vol. i, Pt. 2, 1872. Vol. ii, Pt. 1, 1873.

Archiv fur Anthropologie. 4to, vol. vi, Pt. 3. Bramsschweig, 1873.

Festschrift zur Feier des Hundertjahrigen Bestehens der Gesellschaft Naturforschender Freunde zu Berlin. 4to vol., pp. 264, with 20 plates. Berlin, 1873.

Jahrbuch der Kaiserlich-koniglichen geologischen Gesellschaft. 8vo, vol. xxiii, No. 3, 3 plates. Wien, 1873.

Horae Societatis Entomologicae Rossicae. 8vo, vol. viii, Nos. 3 and 4, 2 plates. Vol. ix, Nos. 1 and 2. St. Petersburg, 1871 and 1872.

Bericht der oberosterreichischen Handels-und Gewerbekammer zu Linz. 8vo. Linz, 1872.

Statistischer Bericht der Handels-und Gewerbekammer Oberosterreichs zu Linz nach den Ergebnissen des Jahres 1870. Linz, 1872.

Summareische Berichte betreffende die Verhaltnisse der Industrie, des Handels und Verkehrs Oberosterreichs in Jahre 1871, 1872. Linz, 1872, 1873.

Compte-Rendu de la Societe Entomologique de Belgique. 8vo, No. 96, pp. 12.

Notes on the Avifauna of the Aleutian Islands, especially those west of Unalashka. By W. H. Dall. 8vo, pp. 12. (From Proc. Cal. Acad. Sciences, 1874.)

Contributions to the Study of Yellow Fever. By J. M. Toner and John M. Woodworth. 8vo, pp. 51. Washington, 1874.

Department of the Interior, U. S Geological and Geographical Survey of the Territories. Miscellaneous Publications; No. 4, Synopsis of the Flora of Colorado. By Thomas C. Porter and John M. Coulter. 8vo, pp. 180. Washington, March 20, 1874. *No. 5, Descriptive Catalogue of the Photographs of the U. S. Geological Survey of the Territories for the years 1869 to 1873 inclusive.* W. H. Jackson, Photographer. 8vo, pp. 83. Washington, 1874.

Jenaische Zeitschrift fur Medicin und Naturwissenchaften. 8vo, Bd. i, Hefte 1-4; Bd. vii Hefte 1-4. Leipzig.